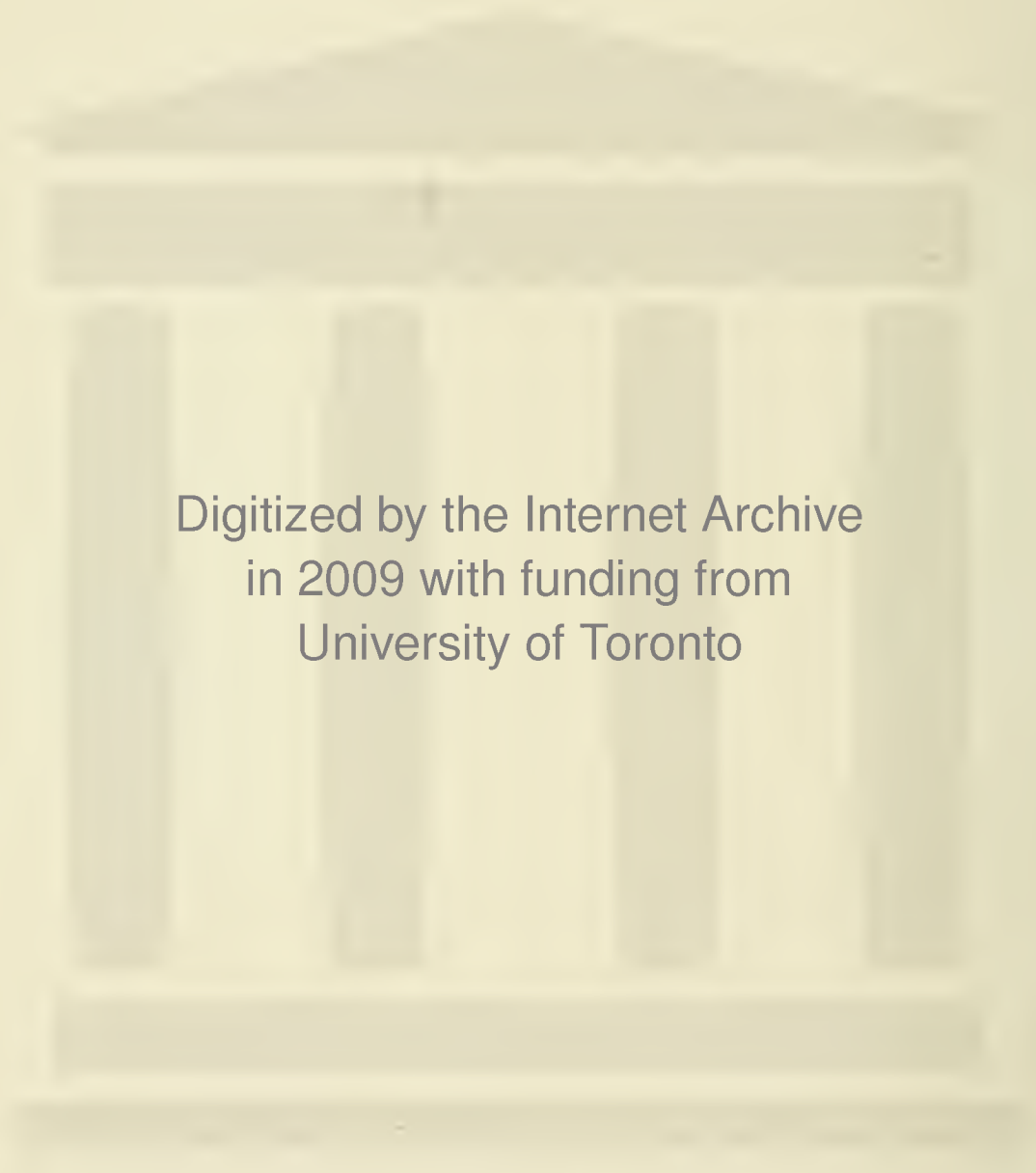

TRANSACTIONS

OF THE

AMERICAN PEDIATRIC SOCIETY

TWENTY-SEVENTH SESSION

HELD AT THE LAUREL HOUSE, LAKEWOOD, N. J.
MAY 24, 25 AND 26, 1915

EDITED BY
LINNAEUS EDFORD LA FÉTRA, M.D.

VOLUME XXVII

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PRESIDENTS

1889. A. Jacobi, M.D.
1890. J. Lewis Smith, M.D.
1891. T. M. Rotch, M.D.
1892. Wm. Osler, M.D.
1893. A. D. Blackader, M.D.
1894. John M. Keating, M.D.
1895. F. Forchheimer, M.D.
1896. Joseph O'Dwyer, M.D.
1897. Samuel S. Adams, M.D.
1898. L. Emmett Holt, M.D.
1899. Wm. P. Northrup, M.D.
1900. Henry Koplik, M.D.
1901. Wm. D. Booker, M.D.
1902. W. S. Christopher, M.D.
1903. J. P. Crozer Griffith, M.D.
1904. Augustus Caillé, M.D.
1905. C. G. Jennings, M.D.
1906. A. Jacobi, M.D.
1907. B. K. Rachford, M.D.
1908. C. G. Kerley, M.D.
1909. Charles P. Putnam, M.D.
1910. David L. Edsall, M.D.
1911. Henry Dwight Chapin, M.D.
1912. Walter Lester Carr, M.D.
1913. John Lovett Morse, M.D.
1914. Samuel McC. Hamill, M.D.
1915. George N. Acker, M.D.

OFFICERS, 1915

President ..... George N. Acker, M.D.
Vice-President ..... Henry L. Coit, M.D.
Secretary ..... Samuel S. Adams, M.D.
Treasurer ..... Chas. Hunter Dunn, M.D.
Recorder and Editor ..... L. E. La Fétra, M.D.
Assistant Editor ..... O. M. Schloss, M.D.

COUNCIL

Alfred Hand, Jr., M.D., *Chairman*

L. E. La Fétra, M.D.
Isaac A. Abt, M.D.
John Howland, M.D.
Fritz B. Talbot, M.D.
D. M. Cowie, M.D.
L. Emmett Holt, M.D.

MEETING PLACES

1888. Washington, D. C. (Organization), September 18.
1889. Washington and Baltimore, September 20 and 21.
1890. New York, June 3 and 4.
1891. Washington, September 22 and 25.
1892. Boston, May 2, 3 and 4.
1893. West Point, N. Y., May 24, 25 and 26.
1894. Washington, May 29 and June 1.
1895. Virginia Hot Springs, May 27, 28 and 29.
1896. Montreal, May 25, 26 and 27.
1897. Washington, May 4, 5 and 6.
1898. Cincinnati, June 1, 2 and 3.
1899. Deer Park, June 27, 28 and 29.
1900. Washington, May 1, 2 and 3.
1901. Niagara Falls, May 27, 28 and 29.
1902. Boston, May 26, 27 and 28.
1903. Washington, May 12, 13 and 14.
1904. Detroit, May 30, 31 and June 1.
1905. Lake George, N. Y., June 19, 20 and 21.
1906. Atlantic City, N. J., May 30, 31 and June 1.
1907. Washington, May 7, 8 and 9.

1908. Delaware Water Gap, May 25, 26 and 27.
1909. Lenox, Mass., May 27 and 28.
1910. Washington, May 3, 4 and 5.
1911. Lake Mohonk, N. Y., May 31 and June 1 and 2.
1912. Hot Springs, Va., May 29, 30 and 31.
1913. Washington, May 5, 6 and 7.
1914. Stockbridge, Mass., May 26, 27 and 28.
1915. Lakewood, N. J., May 24, 25 and 26.
1916. Washington, May 8, 9 and 10.

OFFICERS, 1916

President ..... Rowland G. Freeman, M.D.
Vice-President ..... J. C. Gittings, M.D.
Secretary ..... Samuel S. Adams, M.D.
Treasurer ..... Chas. Hunter Dunn, M.D.
Recorder and Editor ..... L. E. La Fétra, M.D.
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John Howland, M.D. — L. Emmett Holt, M.D.
Fritz B. Talbot, M.D. — Charles A. Fife, M.D.

MEMBERS

1903. Abt, Isaac A., M.D. ..... 4810 Kenwood Avenue, Chicago
1893. Acker, George N., M.D. ..... 913 Sixteenth Street, Washington
O Adams, Samuel S., M.D. ..... 1801 Connecticutt Ave., N. W., Washington
O Blackader, A. D., M.D. ..... 236 Mountain Street, Montreal
1911. Bowditch, Henry I., M.D. ..... 416 Marlborough Street, Boston
1911. Butterworth, William W., M.D., 3914 Prytania Street, New Orleans, La.
O Caillé, Augustus, M.D. ..... 753 Madison Avenue, New York
1911. Carpenter, Howard C., M.D. ..... 1805 Spruce Street, Philadelphia
O Carr, Walter Lester, M.D. ..... 68 West Fifty-First Street, New York
O Chapin, Henry Dwight, M.D. ..... 51 West Fifty-First Street, New York
1897. Churchill, F. S., M.D. ..... 1259 North State Street, Chicago
1910. Coit, Henry L., M.D. ..... 277 Mt. Prospect Avenue, Newark, N. J.
1909. Cowie, D. M., M.D. ..... Lawrence Building, Ann Arbor, Mich.
1891. Crandall, Floyd M., M.D. ..... 113 West Ninety-Fifth Street, New York
O Dorning, John, M.D. ..... 124 West Eighty-First Street, New York
1906. Dunn, Charles Hunter, M.D. ..... 220 Marlborough Street, Boston
1904. Eaton, Percival J., M.D. ..... 131 N. Highland Avenue, E. E., Pittsburgh
1907. Fife, Charles A., M.D. ..... 2033 Locust Street, Philadelphia
1895. Freeman, Rowland G., M.D. ..... 211 West Fifty-Seventh Street, New York
1913. Friedlander, Alfred, M.D. ..... 4 West Seventh Street, Cincinnati
1913. Gerstenberger, Henry J., M.D. ..... Osborn Building, Cleveland
1910. Gittings, J. C., M.D. ..... 3492 Chestnut Street, Philadelphia
1897. Graham, E. E., M.D. ..... 1713 Spruce Street, Philadelphia
1892. Griffith, J. P. Crozer, M.D. ..... 1810 Spruce Street, Philadelphia
1898. Hamill, S. McC., M.D. ..... 1822 Spruce Street, Philadelphia
1902. Hand, Alfred, Jr., M.D. ..... 1724 Pine Street, Philadelphia
1910. Haynes, Royal S., M.D. ..... 213 West Seventieth Street, New York
1909. Heiman, Henry, M.D. ..... 30 West Eighty-Eighth Street, New York

1914. Helmholz, Henry F., M.D.....1005 Michigan Avenue, Evanston, Ill.
1910. Herrman, Charles, M.D.....250 West Eighty-Eighth Street, New York
1915. Hess, Alfred F., M.D.....16 West Eighty-Sixth Street, New York
O Holt, L. Emmett, M.D.....14 West Fifty-Fifth Street, New York
1913. Hoobler, B. Raymond, M.D.....1563 David Whitney Bldg., Detroit
1905. Howland, John, M.D.....20 East Eager Street, Baltimore
O Huber, F., M.D.....209 East Seventeenth Street, New York
O Jacobi, A., M.D.....19 East Forty-Seventh Street, New York
1896. Kerley, Charles G., M.D.....132 W. Eighty-First Street, New York
1905. Knox, J. H. Mason, M.D.....804 Cathedral Street, Baltimore
O Koplik, Henry, M.D.....30 East Sixty-Second Street, New York
1903. Ladd, Maynard, M.D.....270 Clarendon Street, Boston
1903. La Fétra, Linnæus E., M.D.....113 East Sixty-First Street, New York
1911. Lucas, William Palmer, M.D...University of California, San Francisco
1912. McClanahan, H. M., M.D.....468 Brandeis Building, Omaha
1909. Machell, H. T., M.D.....95 Bellevue Avenue, W., Toronto
1898. Miller, D. J. Milton, M.D...127 S. Illinois Avenue, Atlantic City, N. J.
1896. Morse, J. Lovett, M.D.....70 Bay State Road, Boston
1908. Nicoll, Matthias, Jr., M.D.....124 East Sixtieth Street, New York
O Northrup, William P., M.D..57 East Seventy-Ninth Street, New York
1915. Park, Edwards A., M.D.....Johns Hopkins Hospital, Baltimore
1910. Pisek, Godfrey R., M.D.....36 East Sixty-Second Street, New York
1912. Porter, R. Langley, M.D.....240 Stockton Street, San Francisco
1891. Rachford, B. K., M.D.....323 Broadway, Cincinnati
1905. Ruhräh, John, M.D.....839 North Eutaw Street, Baltimore
1900. Saunders, E. W., M.D.....3003 Lafayette Avenue, St. Louis, Mo.
1912. Schloss, Oscar M., M.D....172 West Seventy-Ninth Street, New York
1913. Sedgwick, Julius P., M.D.....2015 Kenwood Parkway, Minneapolis
1902. Shaw, Henry L. K., M.D.....361 State Street, Albany
1914. Sherman, DeWitt, H., M.D.....680 West Ferry Street, Buffalo
1915. Smith, Richard M., M.D.....329 Beacon Street, Boston
1891. Snow, Irving M., M.D.....476 Franklin Street, Buffalo
1905. Southworth, Thomas S., M.D.....807 Madison Avenue, New York
1911. Talbot, Fritz B., M.D.....311 Beacon Street, Boston
1910. Tileston, Wilder, M.D.....424 Temple Street, New Haven
1914. Van Ingen, Philip, M.D.....125 East Seventy-First Street, New York
1912. Veeder, Borden S., M.D.....1806 Locust Street, St. Louis, Mo.
1914. Walls, Frank X., M.D.....1208-30 North Michigan Boulevard, Chicago
1895. Wentworth, A. H., M.D.....352 Marlborough Street, Boston
1896. Westcott, Thompson S., M.D.....1720 Pine Street, Philadelphia
1913. Wilcox, Herbert B., M.D.....159 East Seventieth Street, New York
O Winters, J. E., M.D.....25 West Thirty-Seventh Street, New York

Note.—The first column gives the date of election to the Society. The organizers of the Society are designated by "O," the date being 1888.

HONORARY MEMBERS

Dr. John Thompson.....Edinburgh, Scotland
Dr. George F. Still.....London, England
Dr. O. Heubner.....Berlin, Germany
Dr. William Osler.....Oxford, England
Dr. A. Baginsky.....Berlin, Germany
Dr. V. Hutinel.....Paris, France
Dr. Charles Rauchfuss.....Petrograd, Russia

Deceased

JOHN A. JEFFRIES, M.D.
Born, September 2, 1859,
Died, March 26, 1892.

THOMAS F. SHERMAN, M.D.
Born, March 17, 1856,
Died, September 26, 1893.

JOHN M. KEATING, M.D.
Born, April 20, 1852,
Died, November 17, 1893.

CHARLES WARRINGTON EARLE, M.D.
Born, 1845,
Died, November 19, 1893.

J. LEWIS SMITH, M.D.
Born, October 15, 1827,
Died, June 9, 1897.

JOSEPH O'DWYER, M.D.
Born, October 12, 1841,
Died, January 7, 1898.

JOHN HENRY FRUITNIGHT, M.D.
Born, November 9, 1851,
Died, December 18, 1900.

FREDERICK A. PACKARD, M.D.
Born, November 17, 1862,
Died, November 1, 1902.

WALTER S. CHRISTOPHER, M.D.
Born, 1859,
Died, March 2, 1905.

LEROY MILTON YALE, M.D.
Born, February 12, 1841.
Died, September 12, 1906.

JAMES PARK WEST, M.D.
Born, June 27, 1858,
Died, June 25, 1908.

FREDERICK FORCHHEIMER, M.D.
Born, 1853,
Died, June 1, 1913.

THOMAS MORGAN ROTCH, M.D.
Born, 1850,
Died, March 9, 1914.

CHARLES P. PUTNAM, M..D
Born, 1845,
Died, April 22, 1914.

CONSTITUTION AND BY-LAWS OF THE AMERICAN PEDIATRIC SOCIETY

ARTICLE I

Name and Object of the Society

The Society shall be known as the American Pediatric Society, and shall hold an annual meeting.

It has for its object the advancement of the knowledge of physiology, pathology and therapeutics of infancy and childhood.

ARTICLE II

Proceedings

The proceedings shall consist of:

1. Discussions on subjects previously selected.
2. Original communications.
3. Demonstrations of gross and microscopic preparations, apparatus, and instruments.

ARTICLE III

Members

The Society shall be composed of three classes of members to be designated: (1) active members; (2) emeritus members, and (3) honorary members.

The number of active members shall be limited to seventy-five.

The number of emeritus members shall be unlimited.

The number of honorary members shall be limited to twenty-five.

ARTICLE IV

Election of Active Members

Nominations to membership, signed by two members of the Society, must be made in writing at least one meeting prior to election.

Nominations should be made to the Secretary, whose duty it shall be to require the nominators to write a personal letter endorsing and stating the qualifications of the nominee, and at the same time furnishing a list of the nominee's professional position and publications, with reprints of the latter, when obtainable.

It shall be the duty of the Secretary to transmit to the Chairman of the Council all the above papers pertaining to each nominee, at least three months prior to his possible election.*

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* In the event that required information relating to candidates for membership is not furnished to the Secretary by three months before the time of the meeting at which they would be considered, such candidates for election shall be held over for another year. (Resolution adopted 1912.)

The Chairman of the Council shall transmit the above-named papers to the other members of the Council in the order of their seniority as Council members, the junior member of the Council returning them to the Secretary.

It shall also be the duty of the Secretary to furnish a printed list of all nominees at least once a year to every member of the Society, and it shall be the duty of the members of the Society, without solicitation, to furnish the Council with any information that they may possess as to the fitness of the nominees to become members of the Society.

On nomination by the Council, members shall be elected by the Society by ballot. A two-thirds vote of the members present shall be necessary for election.

ARTICLE V

Election of Emeritus and Honorary Members

Active members who have served fifteen years and have paid all their dues, may on their request and on the recommendation of the Council be made emeritus members. They shall be entitled to attend meetings and read papers, when they so desire, but cannot vote.

Physicians of sufficient eminence to merit the distinction may be elected honorary members, to a number not exceeding twenty-five. Such members shall be entitled to attend all meetings and take part in the proceedings, but cannot vote. Honorary members shall be elected in the same way as active members.

ARTICLE VI

Initiation Fee and Annual Dues

Election to membership shall be completed by the payment of an initiation fee of $10.

Each active member shall pay an annual fee, the amount of which shall be decided at each annual meeting.

Emeritus and honorary members shall be exempt from fees.

ARTICLE VII

Officers

The officers shall consist of a President, Vice-President, Secretary, Recorder [and Editor], Treasurer and a Delegate to the Congress of Physicians and Surgeons.

The officers shall be elected annually on nomination by the Council.

ARTICLE VIII

Duties of Officers

The duties of the President, Vice-President, Secretary and Treasurer shall be those usual to these offices. The Recorder [and Editor] shall secure the papers read and see that proper notes are taken of the discussion thereon for the use of the committee on publication.

ARTICLE IX

The Council

The Council shall consist of seven members, the senior member being Chairman. One member of the Council shall be elected each year. Four members shall constitute a quorum. The senior member shall retire at the end of each year and shall not be immediately eligible to reelection.

ARTICLE X

Duties of Council

The duties of the Council shall be to consider nominations for membership and report them to the Society. The votes of four members of the Council shall be required for nomination. The Council shall also nominate the officers of the Society and shall decide the time and place of meeting.

ARTICLE XI

Committee of Arrangements

The President, Secretary and the Chairman of the Council shall constitute a committee of arrangements, the President being chairman of this committee. They shall arrange the details of the meeting and the preparation of the program, and they shall have the authority to invite guests to attend the meeting and to participate in the discussion.

ARTICLE XII

Publication Committee

The Secretary, Treasurer and Recorder shall constitute a committee on publication, to which shall be referred all papers, reports and other matters intended for publication.

All papers presented shall become the property of the Society.

ARTICLE XIII

Amendment of Constitution and By-Laws

Proposals for amendments of the constitution and by-laws must have been made at the meeting previous to that at which they are

voted on, the notice for which shall contain an announcement of the proposed changes. Such changes shall require, for their adoption, an affirmative vote of three-fourths of the active members present.

ARTICLE XIV

Termination of Membership

A member may be expelled from the Society for conduct unbecoming a physician and a gentleman. In such cases, formal charges must be made in writing by two members, which shall be referred to the Council.

Active membership shall lapse for any one of the following reasons:

(1) Absence from three consecutive meetings without excuse acceptable to the council; (2) failure to present and read a paper for five consecutive years; the Secretary in both these cases shall notify members one year before date of possible lapse; (3) non-payment of dues for two years, two notifications having been sent by the Treasurer.

ARTICLE XV

Quorum

Any number of members present at the appointed time of the annual meeting, shall constitute a quorum for the transaction of ordinary business, but for the election of members, fifteen shall be necessary for a quorum; and for the expulsion of members, or for altering the constitution and by-laws, twenty-five members shall be necessary.

ARTICLE XVI

Order of Business

1. The President shall call the meeting to order and deliver an annual address. In his absence the Vice-President shall preside, and in the absence of all these officers, the Chairman of the Council.

2. When a general discussion is arranged by the Council, the two members appointed to open the discussion shall not occupy more than twenty minutes each; subsequent speakers shall be restricted to ten minutes each.

3. Papers shall not exceed twenty minutes in the reading. In the discussion following the reading of such papers, remarks shall be limited to ten minutes. Should any paper be too long to be read in

twenty minutes, the writer must prepare an abstract which can be read within that time.*

4. At the business session the report of the Council as a committee on nominations to office and to membership, shall be made, and ballot shall be held thereon.

Adopted May 28, 1909.

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* In order to expedite the publication of the Transactions all members whose papers are to appear in the volume, be required either to have their articles in the hands of the editor before July 1 or to have them in process of publication in some medical journal by that date. In the latter event, the editor of the Transactions is to be notified what journal will publish the paper and reprints or galley proofs are to be furnished to him as soon as possible. (Resolution adopted 1912.)

MINUTES OF THE TWENTY-SEVENTH ANNUAL MEETING OF THE AMERICAN PEDIATRIC SOCIETY

Held at the Laurel House, Lakewood, N. J., May 24, 25 and 26, 1915

The meeting was called to order at 10 a. m., on Monday, May 24, by the President, Dr. George N. Acker, Washington, D. C.

The following members were present during the session: Drs. Isaac A. Abt, Chicago; George N. Acker, Washington; Samuel S. Adams, Washington; A. D. Blackader, Montreal; Augustus Caillé, New York; Howard C. Carpenter, Philadelphia; Walter Lester Carr, New York; Henry Dwight Chapin, New York; F. S. Churchill, Chicago; Henry L. Coit, Newark; D. M. Cowie, Ann Arbor; Charles Hunter Dunn, Boston; Charles A. Fife, Philadelphia; Rowland G. Freeman, New York; Henry John Gerstenberger, Cleveland; John Claxton Gittings, Philadelphia; Edwin E. Graham, Philadelphia; J. P. Crozer Griffith, Philadelphia; S. McC. Hamill, Philadelphia; Alfred Hand, Jr., Philadelphia; Royal S. Haynes, New York; Henry Heiman, New York; Charles Herrman, New York; L. Emmett Holt, New York; B. Raymond Hoobler, Detroit; John Howland, Baltimore; A. Jacobi, New York; Charles G. Kerley, New York; J. H. M. Knox, Baltimore; Henry Koplik, New York; Maynard Ladd, Boston; L. E. LaFétra, New York; D. J. Milton Miller, Atlantic City; J. Lovett Morse, Boston; William P. Northrup, New York; Godfrey R. Pisek, New York; R. Langley Porter, San Francisco; John Ruhräh, Baltimore; E. W. Saunders, St. Louis; Oscar M. Schloss, New York; Julius P. Sedgwick, Minneapolis; Henry L. K. Shaw, Albany; DeWitt H. Sherman, Buffalo; Thomas S. Southworth, New York; Fritz B. Talbot, Boston; Wilder Tileston, New Haven; Philip Van Ingen, New York; Frank X. Walls, Chicago; Thompson S. Westcott, Philadelphia; and Herbert B. Wilcox, New York. (Fifty in all.)

There were introduced as guests, Drs. George W. Lawrence, Lakewood; Irving H. Hance, Lakewood; C. H. Laws, Minneapolis; Julius Rudisch, New York; R. B. Kimball, New York; E. A. Morgan, New York; Louis C. Schroeder, New York; H. J. Morgan, Toledo; F. W. Howe, Boston; and C. U. Moore, Rochester, Minn.

The Minutes of the twenty-sixth annual meeting were approved as published in the Transactions of the Society.

The following papers were read:

1. The President's Address, by Dr. George N. Acker.

2. Dr. Thomas S. Southworth: "Cubic Air-Space for Institutional Bottle-Fed Infants."

The paper was discussed by Drs. Holt, Freeman, LaFétra, Hamill, Coit, Talbot and Adams; and the discussion was closed by Southworth.

3. Dr. Henry Heiman: "Para-Pharyngeal Abscess as Distinguished from Peri-Tonsillar and Retro-Pharyngeal Abscesses."

The paper was discussed by Drs. Tileston, Southworth, Porter, LaFétra, Carr and Griffith; and the discussion was closed by Dr. Heiman.

4. Dr. Royal S. Haynes: "A Contribution to Ductless Gland Therapy."

The paper was discussed by Drs. Herrman and Griffith; and the discussion was closed by Dr. Haynes.

5. Dr. Fritz B. Talbot: "Energy Metabolism of an Infant with Congenital Absence of the Cerebral Hemispheres."

This paper was discussed by Drs. Howland, Tileston, the discussion being closed by Dr. Talbot.

6. Drs. E. W. Saunders and T. Wistar White: "Report of Cases of Various Types of Idiosyncrasy to Milk."

7. Dr. Oscar M. Schloss: "Allergy to Common Foods."

These two papers were discussed by Drs. Holt, Howland, Talbot, Morse, Tileston, Hoobler, Hamill, Haynes, Heiman, Freeman, Porter, Cowie, Griffith and Abt; and the discussion was closed by Dr. Schloss.

8. Dr. B. Raymond Hoobler: "Energy Metabolism of a Two-Months'-Old Child Fed on a Prolonged Protein-Rich Diet."

The paper was discussed by Drs. Howland and Talbot, the discussion being closed by Dr. Hoobler.

9. Drs. H. J. Gerstenberger, H. D. Haskins, H. H. McCregor, Ph. D., and H. O. Ruh: "A Further Step in the Adaptation of an Artificial Food to Human Milk."

The paper was discussed by Drs. Coit and Hoobler; the discussion being closed by Dr. Gerstenberger.

10. Dr. Maynard Ladd: "Homogenized Olive-Oil Fat-Free Milk-Mixture in Cases of Difficult Feeding."

11. Drs. Wilder Tileston and Charles W. Comfort: "The Total Nonprotein Nitrogen and the Urea of the Blood, and the Phenolsulphonephthalein Excretion in Infancy and Childhood."

This paper was discussed by Drs. Morse, Freeman and Koplik; and the discussion was closed by Dr. Tileston.

12. Dr. Rowland G. Freeman: "The X-Ray in the Diagnosis of Thoracic Disease in Children, Illustrated by Lantern Slides."

The paper was discussed by Drs. Howland, Koplik, Dunn, Holt, Gittings, Morse, Cowie and Hand; and the discussion was closed by Dr. Freeman.

13. Dr. Samuel S. Adams: "Transposition of Viscera in an Infant."

14. Drs. L. Emmett Holt, Angela Courtney and Helen M. Fales: "The Composition of Woman's Milk."

This paper was discussed by Drs. Gerstenberger and Southworth, the discussion being closed by Dr. Holt.

15. Dr. Henry Dwight Chapin: "A Plea for Accurate Statistics in Infants' Institutions."

This paper was discussed by Drs. Hamill Porter, Van Ingen, Southworth, Knox and Shaw; and the discussion was closed by Dr. Chapin.

16. Drs. Charles Hunter Dunn and Langley Porter: "Some Studies on Sugar in Infant Feeding."

This paper was discussed by Drs. Schloss, Porter, Abt, Holt, Koplik, Gerstenberger, Sherman and Griffith; and the discussion was closed by Dr. Dunn.

17. Drs. John Howland and W. McKim Marriott: "The Indications for Treatment of Severe Diarrhea in Infancy."

The paper was discussed by Drs. Koplik, Schloss, Gerstenberger, Kerley, Abt, Blackader, Sedgwick, Morse and Talbot; and the discussion was closed by Dr. Howland.

18. Dr. Henry Koplik: "Chorea and Syphilis."

The paper was discussed by Drs. LaFétra, Saunders and Abt, the discussion being closed by Dr. Koplik.

19. Drs. Oscar M. Schloss and Louis C. Schroeder: "The Reducing Substance in Spinal Fluid."

This paper was discussed by Drs. Hand, Hoobler and Abt, the discussion being closed by Dr. Schloss.

20. Dr. J. P. Crozer Griffith: "Acute Cerebellar Ataxia, with the Report of a Case."

21. Dr. A. Caillé: "Foreign-Body Pneumonias."

Dr. Caillé's paper was discussed by Drs. Graham, Miller and Koplik.

22. Dr. Charles Herrman: "Meningitis in the New-Born, with Report of a Case."

The paper was discussed by Drs. Sedgwick, Koplik and LaFétra; and the discussion was closed by Dr. Herrman.

23. Dr. Charles Herrman: "A Case of Amaurotic Family Idiocy in One of Twins."

This paper was discussed by Dr. Koplik, the discussion being closed by Dr. Herrman.

24. Dr. William P. Northrup: "General Tuberculosis, Including the Skin, in a Child."

25. Dr. Herbert B. Wilcox: "Macewen's Sign—An Analysis of the Anatomical Conditions which Enter into the Production of this Sign, and the Value of its Presence in Diagnosticating Changes in Intracranial Pressure."

The paper was discussed by Drs. LaFétra and Koplik.

26. Drs. Godfrey R. Pisek and M. C. Pease: "A Preliminary Report on the Pneumonias in Children, with Special Reference to their Epidemiology."

The paper was discussed by Drs. Graham, Sedgwick and Blackader; and the discussion was closed by Dr. Pisek.

27. Dr. John Lovett Morse: "An Unusual Case of Congenital Heart Disease, with Demonstration of Specimen."

The paper was discussed by Drs. Hand, Northrup, and Howland; and the discussion was closed by Dr. Morse.

28. Dr. J. H. Mason Knox: "Report of a Case of Myelogenous Leukemia in an Infant of Nine Months."

The paper was discussed by Dr. Blackader, the discussion being closed by Dr. Knox.

29. Dr. Julius P. Sedgwick: "The Hydrogen Ionic Concentration of the Gastric and Duodenal Contents in Children."

The paper was discussed by Dr. Gerstenberger, the discussion being closed by Dr. Sedgwick.

30. REPORT OF THE COMMITTEE ON VULVOVAGINITIS.

Dr. J. Claxton Gittings: "Réeumé of Reports Received from Health Officers and Physicians."

Dr. Charles A. Fife: "Résumé of Reports Received from Bacteriologists and Gynecologists."

Dr. Howard Childs Carpenter: "Résumé of Reports Received from Hospitals, Homes and Social Service Departments."

Discussion on these reports was postponed until the business session, when, after a long discussion, participated in by a great many of the members present, a motion was passed tc continue the committee and refer the report back to them, with instructions to report again at the next annual meeting, they having the privilege of getting an additional information they might need.

31. Dr. DeWitt H. Sherman: "Some Interesting Facts Plainly Brought out by a Chart Method of Studying and Managing Cases of Diabetes Mellitus in Children."

32. Drs. Alfred Hand, Jr., and Harry Deaver: "Differential Diagnosis of Stenosis and Spasm of the Pylorus."

This paper was discussed by Drs. Herrman, Coit, and Miller; and the discussion was closed by Drs. Deaver and Hand.

The following papers were read by title::

1. Dr. Francis Huber: "Impacted Prostatic Calculus (Cystin) in a Boy Five Years Old."

2. Dr. Francis Huber: "Acute Infectious Endocarditis (Streptococcus Attenuans) in a Child One Year Old, with Necropsy.

3. Drs. John Howland and W. McKim Marriott: "Investigation of the Calcium Content of the Blood in Rickets."

Dr. Huber was ill and could not attend the meeting.

EXECUTIVE SESSION, WEDNESDAY MORNING, MAY 26

The Report of the Council was read by the Chairman of the Council, Dr. Alfred Hand, Jr.

The Council granted excuses for absence to Dr. Henry F. Helmholz and Dr. William P. Lucas.

It accepted the resignations of Dr. David Bovaird, Jr., and Dr. Frank S. Meara.

The following nominations were submitted to the Society: For President, Dr. Rowland G. Freeman; for Vice-President, Dr. J. C. Gittings; for Secretary, Dr. Samuel S. Adams; for Treasurer, Dr. Charles Hunter Dunn; for Recorder-Editor, Dr. L. E. LaFétra; for Assistant Recorder-Editor, Dr. Oscar M. Schloss; for Member of the Council, Dr. Charles A. Fife; for Committee of Arrangements at the Congress of American Physicians and Surgeons, Dr. S. S. Adams.

For the place and time of the next meeting the Council recommended Washington, D. C., during the meeting of the Congress.

The Council reported that the Treasurer's Report had been received, audited and found correct.

The annual assessment for the ensuing year was fixed at $10.00.

The offer by the American Medical Association to publish the Transactions had been accepted.

The following names were recommended to the Society for election to membership; Dr. Richard M. Smith, Boston; Dr. Alfred F. Hess, New York; and Dr. Edwards A. Park, Baltimore.

The Report of the Council was adopted.

The Amendments to the Constitution offered May 27, 1914, to be voted on at the meeting of May, 1915, were then taken up and all were adopted.

Dr. Howland offered the following amendment: That the reading length of papers be limited to fifteen, instead of twenty minutes; and that discussions be limited to five, instead of ten minutes.

Dr. Adams moved that a vote of thanks be given to Dr. Irving H. Hance and the physicians of Lakewood who had made arrangements for the entertainment of the Society; to the Country Club, the Golf Club, the Management of the Laurel House, and to Mr. Gould. The motion was seconded and carried.

The Report of the Committee on Vulvovaginitis was then taken up and discussed in detail, with the result already mentioned.

Dr. Adams proposed that a vote of thanks be given the members of the Committee on Vulvovaginitis for their untiring labor in collecting the statistics and preparing the report. The motion was seconded and carried.

The Report of the Committee on the Child Labor Problem was presented by Dr. Philip Van Ingen, the Chairman of the Committee.

Dr. Hamill made a motion that the Committee be continued so as to be able to complete its work. The motion was carried.

The Report of the Committee to Cooperate with the Federal Children's Bureau was presented by Dr. S. McC. Hamill, the Chairman of the Committee.

Dr. Adams moved the continuance of this Committee. The motion was carried.

The scientific work was then resumed and finished.

Dr. S. S. Adams made the following comment on the meeting: "I want to call the attention of the members of the society to a significant fact. This is my twenty-fourth year as Secretary of the American Pediatric Society, and this is the best record we have ever had. There were fifty members present out of seventy. Two of the twenty absentees have resigned. All the papers were read by their authors except three, which were read by title. There was also an extra paper presented. Two of the papers read by title were those of a member kept at home by sickness; and the other was by men who had already presented one paper and thought best to have their second read by title. This, for the efficiency of the work, beats every other meeting we have had. It shows the great enthusiasm of the members. I wanted to make the statement, so that it may go on record."

Adjourned at 11 a. m.

S. S. Adams, Secretary.
L. E. LaFétra, Recorder.

SOME PRESENT DAY PROBLEMS IN PEDIATRICS

GEORGE N. ACKER, M.D.
WASHINGTON, D. C.

PRESIDENT'S ADDRESS

Permit me, gentlemen, to congratulate you on the twenty-seventh anniversary of our Society, and that so many of us are still spared to prove by our presence the pleasure we experience in its present usefulness, and to cherish the fondest hopes of its future prosperity. The high honor of having been thought worthy of being elected your President has been greatly appreciated, I assure you.

There is perhaps no question of greater moment before the public in general, and our Society in particular, today, than that of child welfare. There can be no better index to our civilization than the interest devoted to the physical and moral uplift of the young. The importance of this subject has found national expression in the establishment of the Children's Bureau of the Department of Labor. This Bureau, under the able guidance of its Director, has already done much creditable work in the investigation of child welfare, not the least interesting and important of which is that done in Johnstown, Pennsylvania.

That the wage of the father is the key to the infant's chance to live, looms up as a feature of the first report of the Children's Bureau in its study of infant mortality in the United States. The death rate among children is in inverse proportion to the earning capacity of their fathers. Infant death rate is five times as high in a poor, unsanitary section of a city as in a better residential district. Babies die much more frequently where the mothers are employed at heavy labor. These facts are among the significant findings of the Children's Bureau, as a result of the investigation of infant mortality in the first city where a careful study was made. It is proposed to extend this inquiry into typical cities in all parts of the country, in order to get an exact measurement of the waste of child life and the measures that may be adopted for its prevention.

The first investigation of the Bureau was made in Johnstown, Pa., because it was representative of the type of town in which there are

no large industries employing women; and further, because its size and good birth registration permitted a study with the limited staff that it was possible to put into the field. Other inquiries are now being made in Manchester, N. H., Brockton, Mass., and Saginaw, Mich.

The report, on which I have drawn extensively for these brief remarks, was compiled by Miss Emma Duke, one of the investigators. It states that the infant death-rate varied in different parts of the same city, being as high as 271 per 1,000 babies in the poorest section where the sanitary conditions were at their worst, or more than five times as great as in the best residential sections. In families where the earnings of the father were less than $10 per week, the infant mortality was 256 per 1,000 babies, whereas in those where the earnings were in excess of $25 the mortality was 84 per 1,000. The report further shows the importance of breast feeding, the mortality being much higher in the artificially fed. In the earliest months of a baby's life exclusive breast-feeding appears to be the only safe method, only 46.6 babies per 1,000 dying under 1 year of age when breast-fed for at least three months, as against 165.8 per 1,000 when fed exclusively on artificial food up to the age of 3 months. In one group of nineteen mothers, whose babies all died, fifteen had been keeping lodgers, an arduous occupation among the foreigners, where the housewife without extra charge often washes and irons for the lodgers in addition to the purchasing and preparation of food. The city was found to bear its share of responsibility in the infant mortality, a high death rate being found in coincidence with neglected streets and unsanitary housing. The report shows for 135 miles of streets and alleys only 11 miles of sewers with 36 outlets; only 64 per cent. of the streets paved and but 11 per cent of the alleys. In houses where the water had to be carried in from outdoors the infant death rate was 198 per 1,000, as against 118 per 1,000 where the water was piped into the house.

According to an estimate of the United States Census Bureau at least 300,000 babies die annually in this country, which means, approximately, one baby out of every eight under 1 year of age; 25 per cent. of the children die before the age of 2 years; and one-third of the total number by the age of 15. Leading sanitarians say that if measures of hygiene and sanitation were observed, this number could be indefinitely reduced. The Children's Bureau is trying to learn the conditions of life most favorable to American babies.

Every mother of a Johnstown baby born in 1911 was visited by women agents of the Children's Bureau and information obtained concerning the environment of the baby; how the father earns his wage and how much; the nature of the mother's work within the home and whether she works outside the home; whether the city streets are safe; the water pure, and the milk clean. The subjects considered in this first report—city and street, environment, housing, mother's age, literacy and married history, manner of feeding the infant, occupation of the mother, the family earnings, etc.—show some of the lines along which the Children's Bureau expects to secure information leading to the reduction of the high rate of infant mortality in the United States.

This most valuable report gives us in a concrete form what we have all known in a general way, and points out how many infants can become strong and develop into useful members of society, so that each unit of the coming generation may grow into magnificent manhood or womanhood more worthy of perpetuating the species. The great mission of the medical profession, as I see it, and that which demands the cooperation of all of us, is to prevent disease. We must work to the uplifting of the race, to render it more virile by the prevention of disease. The problem is an economic one and the report emphasizes the fact that what the infants need is good food and fresh air. Now it becomes the duty of the State to provide these necessities if the parents are unable to do so. The lower death rate in the slums of foreign cities has been the result of governmental aid in the construction of sanitary houses and the making of living conditions generally more favorable. Thus, in Liverpool, in some of the slum areas which have been the subject of clearance schemes, and where displaced tenants have been rehoused on the same areas, a death rate ranging from 40 to 60 per thousand has been reduced by more than one-half by the improved sanitary conditions. In various European countries millions of the public funds have been invested or loaned for the promotion of improved housing.

Many cities have made provision for play grounds for the children, and this has been a great boon for the little ones, giving them a chance to enjoy fresh air and exercise in safety, the result being better lungs, stronger limbs and finer brains than all the schoolrooms unaided in this respect could possibly bring to pass. Not the least happy sign of the changed attitude of "grown-ups" with regard to the rights and

privileges of the little ones is the delightful transformation of former eyesores to places of recreation.

Lunches have been provided in some cities for school children and in some instances this is probably the only good meal the child receives during the day. A school teacher told me that she had recently asked a pupil what she had eaten at breakfast that morning and was told sausage and cheese. It would be a wise measure for the school boards to supervise the luncheons brought by the children, and in the event of its being insufficient or unsuitable to provide a proper meal at a nominal price. It would repay the city to adopt some scheme of this kind, especially in the poorer districts. In this way many of the results of malnutrition might be in a measure overcome. Further than this, day nurseries could be established in connection with the schools where girl pupils might be taught the care of infants under the direction of matrons. This would accomplish a two-fold result in caring for the infants of the poor and at the same time providing valuable training for future wage earning, not at present in the curriculum of most institutions.

The great war which at present is involving such a large proportion of the world's population, will result in the impoverishment of people generally and a great deficiency of foodstuffs. The dire want in the necessities of life will result in an increased morbidity in all diseases and a consequent lowering of vitality. It will be difficult for people to obtain a proper amount of food, and this will find expression in a generation of weaklings. The offspring of the mentally and physically weakened adults escaping the ravages of war, and those hasty marriages encouraged by the authorities will not possess the stamina that is required to make the fight during the first years of life, and the infant mortality will be correspondingly high. Our own country cannot be expected altogether to escape the influences of the war in this respect. With the increased demand for foodstuffs and the soaring prices incident thereto, the children of the poor will be deprived of the requisites for normal nutrition. Already the consequence has been noted, for the report of the Babies' Welfare Association of New York declares that an increase of 161 deaths so far this year over the corresponding period of last year, is due largely to the fact that because of the industrial conditions many homes have been poorly heated and the morbidity of respiratory disease greatly increased.

That much can be done to lessen the evil effects of the war has been shown by the comments of Prof. A. Pinard, a specialist in physical education and an authority on questions relating to natality. He states that the infant mortality in Paris was 21 per cent. less during the first six months of war as compared with the same period of the preceding year, and that maternal mortality also decreased proportionately during the same period. Prof. Pinard attributes this result to the measures taken by the maternal and infant aid society organized at the beginning of the war. The object was to assure to every woman, not only the material and medical aid necessary to birth under proper conditions, but also to remedy, as far as possible, the depression resulting from the absence of husbands in the army. The care given by this society to mothers and infants is held to be responsible for the particularly robust and healthy condition of children born during the period in question.

The subject of the prevention of tuberculosis, more especially in the young, has received so much attention and been so extensively exploited, I may say, in the past few years, that it would seem worth while to give it some passing mention. In lending support to this or that theory of procedure in the prevention of this great malady, there has been little cooperation, and a consequent loss of effectiveness, with gross economic waste. We have, I fear, devoted too much attention to relatively unimportant sources of infection, with a neglect of what is clearly the great danger in child life in this disease, namely, contact infection.

Too much attention has been devoted to an attempt to destroy infectious material at the expense of a building up of individual resistance by good food and proper hygiene. These efforts have not been attended with the results expected by their ardent advocates and while highly commendable and worthy to be continued, are yet open to the criticism, that much of the time and money so expended might have been, with greater advantage, devoted to the bettering of environment. The various agencies which are now working out these problems could be brought together in a more perfect cooperation, whereby funds and energy might be conserved for more sustained and successful accomplishment. There can be no doubt that much of the money now expended in the inspection and destruction of cattle might be used to greater advantage in providing suitable homes for the thousands of infants now being reared in what may be termed a tuberculous environ-

ment. It is in these first few months of life that the human being is most susceptible to infection and the health officer should have all necessary authority to give protection to these little ones in this period. He should have ample power to remove them from dangerous to sanitary surroundings. Country places should be established, to which children might be sent in place of the city institutions in which many are forced to remain. Under such conditions they might be expected to build up resistance to infection. I doubt very much the wisdom of establishing more institutions in the cities for the care of these children, but that it would be a great blessing to the weakly ones of the slums to enjoy the fresh air of the country and the stimulating breezes of the seashore, there is no question. Municipalities must take charge of such infants. This has been done in certain of the contagious diseases and should be extended to all such conditions as interfere with proper usefulness of the future citizen.

If the family is unable to provide adequately for its offspring, then it becomes the duty of the State to advise, and if necessary, to remove such children to such environment as will best assist in their physical and moral development. Many of the organized charities have too much red tape and too little authority, and therein fail to meet the indications. That the infant constantly exposed to tuberculous infection from its parents or other members of its family is just as much entitled to protection as authority would promptly give it were the disease smallpox or diphtheria, seems to me perfectly rational; surely the danger is almost as great.

There has never been a time in the history of modern medicine when more unsubstantiated theories were before us for consideration. Everything new is seized with avidity and has its period of popularity, only to be relegated to its proper sphere of usefulness, or more often to oblivion. Thus we find "Twilight sleep," heralded as the panacea for the pains and discomforts of the child-bearing woman, an agent to improve our progeny. It has been with us before, and after a short season of exploitation will pass by, as have like agencies in the past. Already are we beginning to hear of its limitations. Our own special branch of endeavor is not free from similar fads. It would be difficult to enumerate the many ideas introduced with regard to the infant's food, clothing and care. Our Society should take the initiative through committee investigation in determining the value of many activities now before the profession—a separating of the wheat from the chaff.

The members of this organization are in a position, by virtue of their special work and their hospital connections, to work out problems on a large scale and quickly test out the correctness of given theory. The milk question was in great measure solved in just this way.

In the solution of the important problems that confront us at the present time, the dogmatic spirit with which certain investigators approached a consideration of the relative amounts of protein, fat and carbohydrate acceptable to the infant, must have no place. There must be scientific investigation and unbiased judgment, and a willingness to forsake the established when its error is proved. Many things formerly considered settled will come in for modification and we must be prepared to view these corrections in the proper state of mind.

It is to be regretted that, after so many years of earnest study by competent men, we should find such a marked divergence of opinion with respect to the subject of infant feeding in general and the proportions of various food ingredients in particular. It would appear reasonable to assume that by this time it would be possible to formulate some definite rules as to what should enter into the diet of a normal infant deprived of breast milk. The whole subject is chaotic. So many theories and methods of feeding are advanced and defended that it is difficult, if not hopeless, for one not thoroughly familiar with the subject to know just what course to pursue. The underlying principles of infant feeding must ever be the same, whatever be the methods devised to meet them, so that it would be well if we could standardize our methods. This would greatly facilitate our teaching and render unnecessary in the instruction of the student a discussion of untried theories. As it is, the student in the majority of instances leaves the medical college at the completion of his course confused as to the most important subject in the whole realm of pediatrics. I am firmly convinced that with united effort such a reform could be brought about. It is something of a reproach to the pediatrists that this important matter is in such a state, and it is our duty to see that our knowledge of infant feeding be so systematized that there shall not be the speculation in the future that has characterized the past.

We may now, in my judgment, breafly turn our attention with advantage to the needs of our Society. In the history of our organization and the records of its accomplishments, we have just reason for pride, and it is with a view to maintaining the high standard already

attained, that I desire to invite your attention to certain changes, which, to me, seem advisable at this time.

The first of these relates to membership. Is our membership at the present time sufficiently large to include all pediatrists throughout the country doing commendable work? I believe that it is not. I would suggest that this fault could be corrected in one of two ways. First, and preferably, by increasing our present membership; or secondly, by providing for an associate membership, from which men could be advanced to full standing on a basis of merit.

It seems to be an obvious fact, that throughout the country there are today many ardent workers in our special line of endeavor who are doing work of the highest order, who by reason of our limitations are unable to be admitted to our number. We, under such circumstances, are not only depriving these men of the distinction that a membership in our Society confers, but are likewise depriving ourselves of the advantage of their counsel.

Now in relation to the apparent present requirements for admission to our body, I fear we are turning too much, or rather too exclusively, to the laboratory side of medicine, with a consequent neglect of the importance of clinical work. I do not wish to be understood as in any measure trying to dampen the ardor of our laboratory investigators, who in the past few years have contributed so much to the perfection of diagnosis and the treatment of disease, but feel that in order to preserve the proper balance our Society membership should be made up of both clinicians and laboratory men. The proper correlation of their various ideas as brought about at our annual meetings would then be conducive to the best results.

With these thoughts in mind I cannot help but think of the many men who at the present time are lending great efforts to the advancement of pediatrics, but in a clinical way. In many instances they are too much occupied clinically to find time for laboratory work themselves, but are in splendid position to verify the work of those, who by inclination and opportunity, are engaged in original research.

I submit these ideas for your earnest consideration, for I am convinced that something must be done along these lines for the good of our organization.

CUBIC AIR SPACE FOR INSTITUTIONAL BOTTLE-FED INFANTS

THOMAS S. SOUTHWORTH
NEW YORK

This study of the cubic air space requisite for institutional infants had its inception as follows: The regulation of this matter in the state of New York is dependent upon the three-fold authority of the laws of the state, the rules of the State Board of Charities, and the regulations of the local boards of health. This leads to some apparent confusion and contradiction, as will be shown by the following extracts:

The public health law of the state, Chapter XLV, of Consolidated Laws, after stating their application "to every institution in this State, incorporated for the express purpose of receiving or caring for orphan, vagrant or destitute children, or juvenile delinquents, except hospitals," provides that:

> The beds in every dormitory in such institution shall be separated by a passage-way of not less than 2 feet in width, and so arranged that under each the air shall freely circulate, and there shall be adequate ventilation of each bed, and each dormitory shall be furnished with such means of ventilation as the local board of health shall prescribe. In every dormitory 600 cubic feet of air space shall be provided and allowed for each bed or occupant, and no more beds or occupants shall be permitted than are thus provided for, unless free and adequate means of ventilation exists approved by the local board of health, and a special permit in writing therefor be granted by such board. . . .

The above law, which was apparently designed to cover well children in institutions, and not infants, and also specifically exempts hospitals, is quoted by the New York Board of Health and made the basis of their allowance of 600 cubic feet per bed in wards containing both sick and well infants, although in practice they at times calculate and issue permits for 50 square feet of floor space per infant if that allows a separation of 2 feet between cribs.

The State Board of Charities of the state of New York also points to the state law as its basic authority but in its own "rules" provides that:

No patient shall be retained at public expense in any ward of any hospital, wholly or partly under private control, unless provision is made for each such patient as follows: In a ward which provides at least 1,200 cubic feet of air space for each bed or occupant thereof, and no more beds or occupants shall be permitted than are thus provided for, unless free and adequate means of ventilation exists, approved by this board, and a special permit in writing be granted by this board specifying the number of beds or amount of cubic air space, in no case to be less than 600 cubic feet for children under 12 years of age, and 800 cubic feet for persons more than 12 years of age which shall, under special circumstances, be allowed. . . .

Also "in a ward in which beds are separated at every point by passage ways of at least three feet in width and are so arranged that under each the air shall freely circulate and provide adequate ventilation."

This rule of the State Board of Charities assumes that persons over twelve years of age require more air space than children under that age. Taken in connection with the state law, its practical working has not only sanctioned quite generally a minimum of 600 cubic feet of air space for infants sick or well, but has been administered in such a way through the issuance of permits as to create a general impression that 600 cubic feet is an adequate maximum. Furthermore, the enforcement of the provision for free and adequate ventilation, upon which the licensing of this minimum depends, seems to cease with an inspection of the window space in each ward without reference to their utilization.

For comparison, let us now turn to the clear-cut definitions and provisions of the ordinances of the City of Chicago, Article IX, ¶1213:

For the purposes of this Article a hospital is hereby defined to mean any institution or place used for the reception or care, temporary or continuous, of two or more sick, injured, or dependent persons. . . .

¶ 1218: In every such hospital, each room occupied or to be occupied by patients shall be of such dimensions as shall give each patient not less than 800 cubic feet of space. Every such room shall have at least one window connecting with the external air for each two beds. Said windows shall be of such dimensions as shall secure to each patient at least 2,400 cubic feet of fresh air per hour by natural ventilation, or in case said windows shall not secure said 2,400 cubic feet of air per hour by natural ventilation, then each room shall additionally be fitted with such appliances for ventilation as shall secure to each patient in said room at least 2,400 cubic feet of fresh air per hour. Each bed shall have at least 80 square feet of floor space.

Please note that no distinction is made in Chicago between infants and adults, or between hospitals and institutions, and that provision is made that facilities for ventilation shall be used for that purpose.

The author's experience of eighteen years of nearly continuous connection with one or more of three institutions caring largely for bottle-fed infants, had impressed him with the belief that 600 cubic feet of air space per infant, under the average conditions obtaining in such institutions, was inadequate and contributory to their mortality.

In the hope of securing some definite data of value and authority, a questionnaire was sent to each member of the American Pediatric Society. The scope of the inquiry was restricted, as far as possible, to bottle-fed infants under one year of age unaccompanied by their mothers.

Thirty-three answers containing sufficient data to incorporate were received from pediatricians in thirteen states, the District of Columbia, and Canada, who reported upon 49 hospitals and institutions containing infants, with which they were connected as visiting physicians.

In answer to the question, "What is the cubic air space per infant in your wards?" the wards of 21 were reported as having 1,000 to 1,500 cubic feet; of 8 as having 700 to 800; and of 5 as having from 300 to 600 cubic feet. Five physicians did not know the cubic air space per patient in their wards, but these and the majority of those reporting the smaller figures for air space laid especial stress upon open windows, free ventilation, and the employment of balconies or roof gardens.

An attempt to discover the extent of state or local regulation concerning required or minimum cubic air space per inmate, developed the fact that New York State (600), Evanston, Ill. (800), Chicago (800), and California (250) alone have such laws. The Minnesota law requires 50 cubic feet of ventilation per minute, per patient, but does not specify the cubic space per patient.

All answers were virtually in the negative to the question, "Do the authorities make any allowance of air space for adult attendants upon the infants?" It is so manifest that each adult attendant on duty in a ward consumes at least as much air as one of the children that it is somewhat surprising that no attention should be paid to this factor when calculating the proper air space per occupant and the permissible number of beds in a ward.

The next question was, "What is the minimum cubic air space with which bottle-fed infants do well in your wards?" The answers to this allow of no very definite deductions or conclusions. The large

majority (21) frankly did not know, had not made any studies, or considered too many factors were involved. Naturally, those having abundant space had not been tempted to experiment with less; but some whose wards allowed 1,000 cubic feet or over considered that any reduction would be deleterious. On the other hand, 14 having 300 to 750 cubic feet considered their results good, though almost all of these made some qualifying remark concerning the number of windows, wide open windows, moving air, and free ventilation. One states that no amount of space is sufficient if windows are kept closed; another, that of two wards with equal cubic space (1,000 cubic feet) the infants did better in the one which had more sunlight and through-ventilation.

Concerning the question, "What is the desirable or optimum air space per crib in wards devoted to bottle-fed infants?" the answers were more definite. Some placed little or no stress upon space, but devoted all their energies to abundant ventilation. One wisely summed the matter up by saying that "it depended upon the position of the ward, the means of ventilation, and the free space about the building, also upon whether there were separate wards for night and day, and whether the wards were in upper or lower stories." To this might be added the capacity of the ward. Two considered 800 to 900 cubic feet sufficient, while five others believed that with satisfactory ventillation good results could be obtained with from 500 to 700. Ten were in favor of 1,000 cubic feet, and three others of 1,100, 1,200 and even 2,000 cubic feet, usually not without some stipulation for free ingress of fresh air. The belief was expressed that separation between beds of 2 meters (6 feet) was more vital than calculated air space.

In view of the apparent uncertainty in some quarters as to the relative requirements of adults and infants, it was deemed advisable to formulate the following question: "Do infants, in your opinion, require the same, less, or more air space than adults in wards devoted solely to the care of each group? Please give reasons for your opinion." Twenty-three expressed definite opinions. Nine of these declared categorically for "more"; 8, for the "same"; and 6, for "less." The latter group apparently based their opinions upon scientific grounds; the two former groups upon experience. The reasons for these opinions are interesting. Of those declaring that infants required less air space than adults, one answered: "Much less; their lung

ventilation is only a fraction of that of the adult." A second answered: "As a rule, somewhat less; CO_2 produced is much less in the infant than in the adult." A third answered: "I prefer more, but think they require less." This answer was somewhat difficult to classify. Two answered: "Infants require less, but relatively to their size, more, because of greater relative metabolism." "All metabolic processes are more active in the infant than the adult."

Those who believed that infants should have the same amount of air space as adults, based their belief upon the statements: "That it is difficult to treat children satisfactorily in hospitals; they do not stand confinement as well as adults." "On the principle that infants are more susceptible to their surroundings." "That there should be greater care in ventilation and frequent use of fresh, moving air—natural ventilation." "That one of the worst effects of over-crowding is the increased opportunity for ward infections of a respiratory nature, these being one of the greatest obstacles to success in feeding wards."

More air space than that allowed for adults is considered necessary by numerous others for similar reasons, namely, because they do best out of doors in winter; the more fresh blowing air, the better children thrive." "They are more susceptible to infection and more depressed by lack of fresh air and sunlight." "They must be widely separated because of the danger of slight infections in infancy." In this connection a very proper emphasis is laid on the floor space as well as the cubic space, and at least five to six feet between beds is recommended as desirable. The employment of screens between the cribs is advocated. Transfer of infections by contact, by over-worked attendants in over-crowded wards, must also be taken into consideration.

It has long been the conviction of the writer that nursing infants are more independent of their surroundings than bottle-fed infants. Even when cared for side by side in the ward, the progress of the nursing infant is usually favorable, while that of the bottle-fed infant is more uncertain. Much of this is due to the maternal nursing, but even in crowded wards the nursing infant apparently does well, whereas when deprived of the breast he does badly in proportion to the crowding. Believing, therefore, that artificially-fed infants should be especially provided with ample space, the following question was introduced: "Do bottle-fed infants require more air space than nursing

infants?" To this, 11 answered "yes," 6 "the same," and 6 "no." One who answered no, asks, "Why should they?" This may perhaps best be answered by those who favored more space, whom I may quote as saying, "Nursing infants are apt to thrive in spite of their environment." "Bottle babies need all advantages possible to overcome the handicap of their artificial feeding." "They are more susceptible and in every way need more care."

Those who consider the same space sufficient emphasize that "Bottle-fed infants have greater need of ventilation—moving air," and that "More light and air go with better hygiene." The opinion that "all require the maximum amount of space" may be contrasted with regulations which practically authorize the employment of a minimum space for these unfortunate babies.

It was at one time common in literature dealing with the construction of children's hospitals to make a distinction between the requirements of cubic air space in so-called "medical" and "surgical" wards. For example, 1,000 cubic feet per patient would be specified for medical cases, and 1,500 cubic feet for surgical cases. In order to test this on the basis of wide practical experience, the following question was formulated: "Can any proper distinction be made between so-called 'medical,' 'surgical' or 'bottle-feeding' wards in the amount of cubic space necessary to each infant? Which, if any, requires the larger amount, and why? Please state the respective optimum amounts." No opinion was expressed by 12; 2 thought that the bottle-fed infant required more space than purely medical and surgical cases; 13 declared that no distinction could be made, which is equivalent to saying that the needs of the different groups is the same. The opinions were expressed that "at least 1,000 cubic feet are necessary for all," and that "all require frequent change of air and, as far as possible, open-air treatment and the use of sun parlors," and that "bottle babies should, if possible, be gotten out of doors"; "those with acute and minor illnesses, whose stay is short, demand less space than feeding cases whose stay is longer." Five took the position that certain special surgical and medical conditions require more than average space, even to the point of putting them by open windows and on open porches. Such were wounds with odor, septic and pyogenic infections, osteomyelitis, empyema, and acute fevers with delirium. Pneumonia was apparently overlooked.

The question, "Would you class the bottle-fed infants cared for in any type of institution as well infants or sick infants?" was inspired by the impression created by the authorities controlling these matters in the state and city of New York, that not only the laws but they themselves looked upon infants placed as dependents in institutions as well infants, and the wards in which they were cared for as "well" wards, irrespective of the subsequent history of the infants while inmates. Of the 29 answers received, 3 considered them to be well. The wards of one of these allow 1,000 cubic feet and upward; another does not give figures for space, but enforces open windows and free ventilation; the third speaks of the greater susceptibility to infection.

The purport of the question not being entirely clear, 13 answered very properly that whether the infants are to be looked upon as well or sick depends on their condition. In this answer there is at least the tacit admission that all infants in such bottle-feeding wards cannot at all times be classed as "well" infants. Thirteen did not hesitate to say that bottle-fed infants should be classed as sick rather than well infants. Some of the reasons given for these views may be noted as follows: "It is quite possible for such infants to be well if proper care is given them; efficient service to each child is the important point." "Not all institution infants are sick infants; the answer depends upon the institution, the caretakers, the intelligence, fidelity and the number of the nurses, and the general hygiene of the institution." Another says: "Of course, well children should not be in an institution at all; those with digestive disturbances I consider sick." One considers the infants "well when of average or nearly average weight." Others, "when gaining well," but "if losing weight or stationary for any considerable period, or gaining very slowly, I should classify them as sick infants." Several from their experience say they are "usually sick," "generally sick," "almost always sick," "the majority may properly be classed as sick," "practically all suffer from chronic digestive disturbances." The position was also taken that "they should be classed as sick on account of the special care required in their nursing and in the preparation and administration of their food."

The significant question was then asked: "Do you consider limited cubic air space an important contributory factor to the high mortality of institution or hospital infants, especially among those bottle-fed?"

Only 4 answers were in the negative; 28 answered yes. Most of the answers accepted limited space as an important and contributory factor; some as most important; others as contributory but not the only or principal factor. One states clearly from his experience: "I think the mortality rises steadily in proportion as the number of cases in the ward is increased."

CONCLUSIONS

Allowing for some divergence of opinion, as impartially stated in recording the answers received, the following conclusions seem to be justified:

1. The majority (21 in number) of the hospitals and institutional wards for infants from which reports of cubic air space were received provide 1,000 cubic feet and upward of air space for each inmate, and only 5 reported 600 cubic feet or less.

2. Even with 1,000 or more cubic feet of air space, free ventilation is deemed highly important, and as the space decreases such free ventilation becomes more and more imperative.

3. No allowance of cubic air space is at present made for the necessary attendants in wards.

4. Reduced cubic air space means less square feet of floor space and less separation between cribs, with proportionately increased opportunity for the spread of cross infections. There is a growing belief that even with free ventilation separation of the beds plays as important a rôle as cubic space. Such adequate separation, however, is only attainable with large cubic air space.

5. On account of their handicaps, bottle-fed infants are more liable to require more space than nursing infants.

6. Bottle-fed infants require as much cubic space as so-called sick "medical," or "surgical" cases among infants.

7. The majority of pediatric physicians believe that infants should have as much cubic air space as adults, if not more, and this is especially true of bottle-fed infants, because they are more susceptible to infection, suffer in their nutrition in confinement, and notoriously do badly in all save the best equipped institutions.

8. Bottle-fed infants when retained for any considerable length of time in hospitals or institutions cannot properly be classed as well infants because a considerable proportion of them suffer both in their

digestion and nutrition, as well as from acute intercurrent affections, and therefore require unusual attention in their feeding and general nursing care.

9. Limited cubic air space, involving limited floor space, is an important contributory factor, though by no means the only factor, in the high mortality of artificially-fed infants, and such crowding in limited space is very commonly the concomitant—if not itself a cause—of faulty hygiene, insufficient care, and inadequate nursing.

10. Even with a liberal allowance of cubic air space free and abundant ventilation is of equal importance. In addition, provision for roof-gardens, porches and sun parlors is advisable, if not imperative.

11. The mere presence of windows does not of itself constitute ventilation, but their proper use must be provided for.

12. A low minimum of cubic space established by law, without definition of what constitutes efficient ventilation and without enforcement, may be more harmful than beneficial, and constitute a virtual license to overcrowd in ill-ventilated wards.

13. The example of the more progressive hospitals and institutions, which provide the larger amounts of air space per infant, together with free ventilation, is to a considerable extent nullified by state and local regulations licensing for the less progressive the employment of minimum air space (contrary to the majority opinion of those best qualified from experience to be judges) for a class of infants among whom there is admittedly an unduly high mortality.

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DISCUSSION

DR. HOLT: I think that Dr. Southworth has done a service in stimulating the interest of the Society in the principle of accurate statistics on this subject, which may serve to change the views of the members regarding it, and may be of benefit to hospital authorities generally. The greatest misapprehension exists among hospital managers and superintendents concerning the special requirements for infants in hospitals. The question has been debated in New York for the last two years, whether the hospital requirements for children and infants are best secured in separate institutions or in branches of large general hospitals. I do not know that it has yet been decided. I have thought that infants and young children are likely to be better cared for in separate institutions, because of the difficulty in obtaining the proper administration, proper nursing, proper general care and special feeding needed for infants or young children when they are placed in large general institutions. Nevertheless, there are some advantages in having children's wards attached to the general

hospitals with their training schools for nurses, their laboratories, their elaborate equipment for diagnosis, the proper modern appliances and treatment and their large corps of consultants. Again, with such an organization interns serving in the general hospital may acquire some experience in the treatment of children's diseases. A larger number of young men may thus obtain some special training in treating children than would be the case if children are treated only in special hospitals. The question is whether the advantages on one side are overbalanced by those on the other. I should like to hear some expression of opinion on the question whether we prefer large special hospitals for children, or should recommend to hospital boards or city authorities that the children should be cared for in special wards of our large general hospitals. On the whole I am inclined to the opinion that the last-mentioned arrangement is the best as a general rule, but that the children's service should be distinct and independent, with a special attending and separate resident physician.

DR. FREEMAN: In regard to the matter of cubic air space, it seems to me that what the children need is not so much air space as freely moving air. You cannot get that in a closed ward, no matter what the air space may be. The children should be where the air is moving from open windows. If kept out of doors, they are better off than in any ward.

Dr. Holt's question as to the comparative advantages of children's wards in general hospitals and special hospitals for children, interested me very much. I did work for many years in children's hospitals, and have recently worked in a general hospital. The disadvantage in our children's institutions is that they have grown up from nursing or foundling institutions, and are not usually equipped for the best work in diagnosis. On the other hand, Dr. Holt's institution started as a babies' hospital. The general hospital will usually afford better facilities for studying cases while the contact with men in other departments enables the pediatrist to get ideas for the treatment of children from learning the latest methods of treatment used for adults.

DR. LAFÉTRA: Besides the cubic air space many other factors have to do with the thriving or lack of progress of artificially fed babies. At Bellevue we have satisfactory air space in our ward for babies. In the premature ward, when it is full, we have 1,000 cubic feet per baby; and when less crowded, as much as 1,700 cubic feet per baby. In the large ward, which contains 42,000 cubic feet, and accommodates twenty-seven babies, there are 1,500 cubic feet per baby. In both these wards it has been found that the babies do better the smaller number of them there are. This brings up the question of why it is aside from the food, that artificially fed babies do less well than breast fed. It seems to me that the answer is in the statement that the fewer the babies, the better they do; because then better attention is given to each baby. If fifty babies are in the ward, there are seldom any additional nurses. The infants then get less individual care. The mothering, the carrying about, that the artificially fed baby gets is very little. The more the nurses can carry the babies about and give them the same sort of treatment they would get if they were breast-fed babies, the better they will thrive. The nurses are very good about doing this when there are only a few babies to attend to, picking them up out of their beds, taking them away from the damp places in which they have been lying, and turning them about; but when there are a great number, that cannot be done.

The matter of providing balconies, sun parlors, freely flowing air, etc., has been insisted on; so I shall not speak of it. I should like, however, to refer to

another matter, and that is the question of adequate nursing in children's wards at night. That is a factor of great importance. It has been emphasized before, but cannot be reiterated too frequently. The space between the beds is also, I think, very important, especially in the winter, when the chances of carrying respiratory infections from one bed to another, if the beds are within striking distance, are very obvious.

DR. HAMILL: As to the question asked by Dr. Holt, the answer depends on what the hospital managers are willing to give in the way of accommodations in general hospitals. There is no question that, as the general hospital wards for children are constituted at the present date, the separate institution is a much more valuable method of caring for children. On the other hand, if hospital managers could be induced to furnish the proper conditions, children could be as well cared for in general hospitals as in children's hospitals, and such an arrangement would contribute much to the reduction of the cost of administration.

As it is now, I know of no general hospital that has a sufficient number of wards to take care of all classes of children. The infants are sometimes separated from the older children, but the institution is unknown to me in which surgical cases and the various general conditions and medical cases in infants are all separated from one another. If such conditions could be created in the general hospital, it might be possible to care for the children satisfactorily in a general institution.

Now the most admirable way to care for young children is the way in which it is done in the Johns Hopkins Hospital, where they have the children's hospital practically connected with the general hospital, and the children's institution is administered as a part of the general hospital. They have also the advantage of having the medical cases separated from the others, and the infants from the older children. It is not an absolute necessity that children's institutions should be separated from the general institutions. The question resolves itself into one of the cost of administration. So far as the point mentioned by Dr. Freeman is concerned, I do not believe that young children suffer from the lack of having sufficient opportunity for proper treatment owing to the inability of their physicians to consult with the representatives of other departments.

DR. COIT: The question of most interest to me is whether an infant artificially fed needs as much cubic air space as an adult does. I do not know what the reason was in the mind of the man who expressed that opinion; but I think it must be due to the fact that the artificially fed infants, often with an insufficient temperature, from a state of atrophy, are radiating heat from their bodies more freely than the normal infant, so that it is more necessary in their cases to be careful about ventilation. I do not believe that Dr. Southworth mentioned, in his paper, this point.

With reference to the hospital, it seems to me that where infants are concerned, most of whom are in a state of atrophy, with no capacity for generating heat, and are radiating heat from their bodies, it is necessary to keep the surrounding air warmer than in other cases. That means more care with reference to the inflow and outflow of air. Many infants' hospitals are poorly equipped, in this respect; and I do not know that any system of ventilation can be regarded as perfect in this particular. Indeed, it has been claimed recently that no system of ventilation can be depended on. In my hospital, we have had to put cheese-cloth in the windows and leave the windows open; but this cannot be

done with atrophic infants, and so for them we keep the windows closed. Something should be done along the line of getting a balance between the ventilation and the air space. I have tried to provide 1,000 cubic feet for each infant, and also to follow what I learned as a young man, to allow the air to pass in and out at the rate of 2 cubic feet a second, which corresponds to an opening 6 inches in diameter. In these atrophic cases, it should flow twice that fast. The infant's condition and capacity to maintain heat must always be taken into consideration.

DR. TALBOT: There is no question that the babies with a subnormal temperature need a higher surrounding temperature than do those with a normal bodily temperature. They need it to keep warm; but in comparing the case of the normal infant with that of the infant with a subnormal temperature, we find that the latter is apparently not due entirely to the fact that it loses heat by radiation from the skin, but to the fact that the human engine is not burning enough fuel to keep the baby's temperature up. For that reason, the temperature has to be elevated from the outside; just as it would have to be if the radiation were greater.

DR. ADAMS: The great advantage in the construction of a hospital depends on the money raised and the architect selected. An architect who does not know anything about the construction of hospitals and will not take any advice from men of experience you may expect to build a hospital in which there are no lights on the stairway when the patients have to be taken up and down at night.

Another point is this: If you have a ladies' board connected with the hospital, and the men do not consider your complaints, call the ladies together and tell them. They are the ones who raise the money, and if you tell them that the hospital is not properly constructed, they will see that you get what you want. I had such an experience some years ago. The men connected with the hospital turned me down; the medical staff agreed with the men; I got the ladies' board together and talked to them, finally winding up by telling them that there was no place for sick babies in Washington except the poorhouse; and *I got the baby ward in a short time.*

If the physician in charge is practicing general medicine, it is doubtful how many concessions you will get. He does not want you to have the special work. He wants the work done in the general wards, and the money expended on that service. In the reorganization of the Georgetown University, I became the head of the Department of Medicine. I assign the men to their positions and can tell them what I want done in the children's ward. When this ward was built, the board had it made large enough in air space for the children to live in.

In regard to the exercise of sick babies in the hospital; it has to me always seemed a sad thing to give a young girl eight to twelve babies to take care of and expect her to do it. If there are, say, ten babies, by the time she gets through with the tenth baby, the first is ready to be attended to again, and there is no time to give them exercise. I have adopted a plan that I have found very good, I have the mothers of the infants come to the hospital and take their babies out in the air for a while each pleasant afternoon. This is much better than having the mothers sitting in the wards and watching, with a critical eye, everything that occurs; and then complaining of it. It gets rid of the mothers, and relieves the nurse for an hour or two of the care of so many babies. In this way, also, you can give the babies exercise.

Some years ago, at the Washington Foundling Hospital, the board employed women for the special purpose of taking the babies out for an airing and to assist the trained nurses. We found that the babies did much better when they were taken out in carriages or carried in the arms. Even the weaklings do better if you can give them some amount of exercise, as Dr. LaFétra suggested.

If the men in charge of hospitals would insist that the child should have an equal chance with, or a greater chance than, the adult for getting fresh air and exercise, there would be some impression made on the rate of infant mortality.

DR. SOUTHWORTH: Dr. Freeman is right in thinking that it may not be so much a question of cubic air space as of freely moving air and other factors; nevertheless, it is important to provide for a sufficient cubic air space, because that is the only way in which you can get at regulation to prevent overcrowding. There are many things besides the air space that enter into the institution problem; but you must have an abundance of cubic air space or you will have overcrowding in the wards and its attendant evils.

A great many of the answers that came to the inquiry indicated that the men thought the windows should be thrown open, winter and summer; or at least, that they tried to have this done. In certain climates this may be possible, but I do not quite see how one would be able, in a good deal of the winter weather that we have in the East, especially around New York, to keep the windows open, and also keep the smaller, marasmic babies warm enough. With closed windows and limited cubic air space these will surely suffer.

There is a constantly growing belief that infants ought not to be put in so-called foundling institutions, but that they should be boarded out. It is rather interesting, however, to note that the strongest agitation for boarding out has been in New York state, and as Dr. Porter will testify, in California, for these are the states that have allowed, in the past, the smallest cubic air space for children in institutions. The deduction is obvious, that with the smaller air space allowed by these states; the results have been so bad that the agitation has grown for the boarding out of babies. There probably would not have been so much clamor for this if the institutions had had a larger air space.

PARAPHARYNGEAL ABSCESS AS DISTINGUISHED FROM RETROPHARYNGEAL AND PERITONSILLAR ABSCESSES

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Ordinarily a retropharyngeal abscess is easily diagnosed, an incision made from within the mouth, the pus evacuated, and an uninterrupted recovery results. In some cases, however, where there is only a retropharyngeal adenitis, no pus may be obtained by the first incision, but may be obtained later when the adenitis has broken down; or, again, the patient may recover without a second operation. In still another class of cases, incision yields little or no pus, the symptoms of fever and pain on swallowing continue, the patient becomes more septic in appearance, the tumefaction seen from within the oral cavity remains the same, while the external swelling usually increases in size. In these cases, the signs may continue unabated or may become progressively worse for weeks, even after repeated, usually unsuccessful, incisions from within the mouth, until a deep external operation is made, when, as a rule, considerable pus is evacuated and the patient recovers. It is with the view of describing, classifying, and attempting to clarify in our minds this last mentioned type of cases that this paper has been written.

History.—In 1903 Broca[1] described two cases of "peripharyngeal" abscess, with acute history, spontaneous rupture, and cure, in infants, one 6 months and one 9 months of age. He says that almost all acute "peripharyngeal" abscesses are "adenophlegmons" and involve the chain of glands along the carotid sheath, as distinguished from those in front of the prevertebral muscles.

Since then Broca, Swain and others, have written more or less extensively on this subject. Further elucidation, however, especially as regards the clinical distinctions between lateral pharyngeal abscess and conditions simulating it, and also as regards the proper method of treatment, may not be amiss. In this paper this type, i. e., the "peripharyngeal" abscess of Broca, is known, for reasons to be mentioned later, as parapharyngeal abscess.

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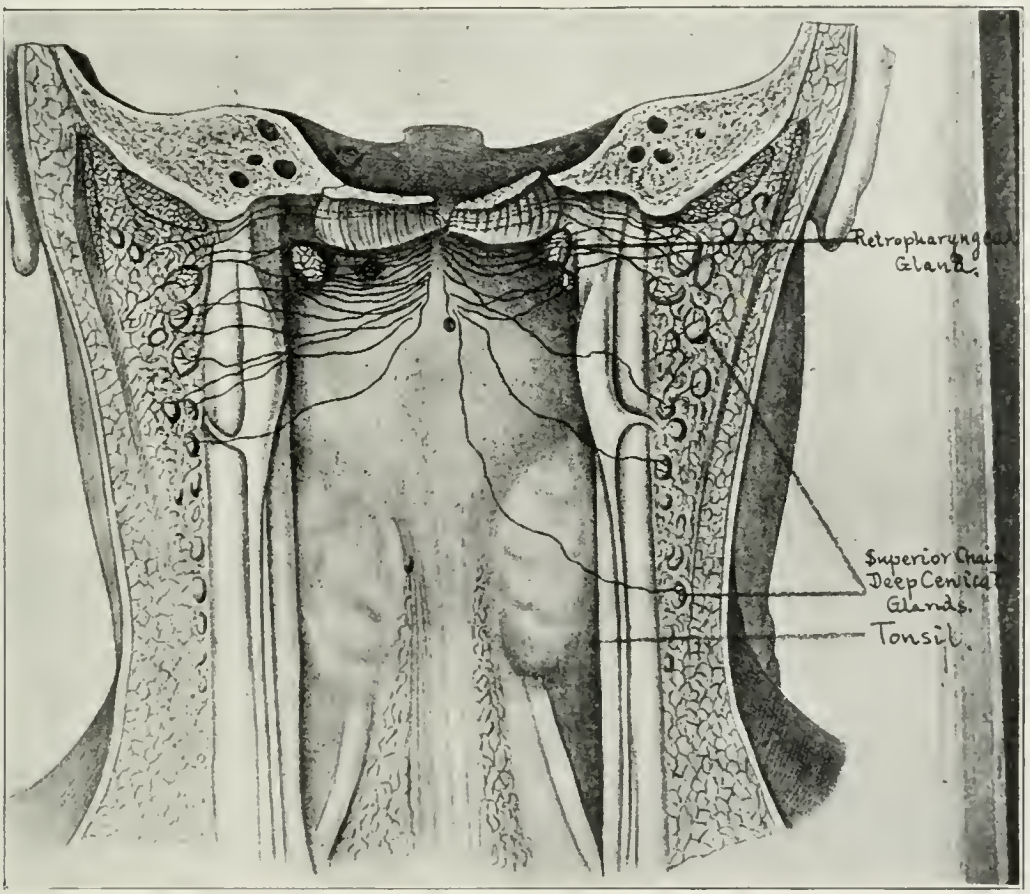
1. Broca, M.: Abcès pèri-pharyngiens, Bull. méd., Paris, 1903, xvii, 579.

The retropharyngeal space is limited above by the base of the skull, while below it extends behind the esophagus and is continued into the posterior mediastinal cavity of the thorax. The lymphatics of this region, as seen by the accompanying illustration from Most,[2] consist of two sets of glands, viz.: (1) the retropharyngeal glands, (2) the deep cervical glands.



The lymphatics of the retropharyngeal space.

1. The retropharyngeal glands, small and few in number, forming a chain on each side of the median line, are found in the buccopharyngeal fascia, posterior to the pharynx and anterior to the arch of the atlas, from which they are separated by the prevertebral muscles. They receive the lymphatic drainage from the nasal cavities, the nasopharynx, and the auditory tubes. These glands atrophy in early childhood; it is extremely rare to find them after the second or third year

2. Most, A.: Zur Topographie und Aetiologie des retropharyngeal Drüsenabscesses, Arch. f. klin. Chir., 1900, lxi.

of life. Most has never observed these glands in autopsies on older children or in adults. It is these glands from which the retropharyngeal abscesses originate.

2. The deep cervical glands, numerous and of large size, form a chain extending along the course of the internal jugular vein and the internal carotid artery, by the side of the pharynx, esophagus, and trachea; and extending from the tip of the mastoid to the root of the neck. They are divided into two groups, the superior and inferior. It is the superior group which interests us in this paper. This superior group drains the mouth, tonsils, palate, pharynx, tongue, posterior part of tongue, nasal fossae, interior of skull, and the deep parts of the head and neck. It is this set of glands that forms the lateral columns of the pharynx, inflammation of which causes parapharyngeal abscess, or the "adenophlegmon" of Broca.

Etiology.—It will be readily understood, from an anatomic point of view, how any inflammation of the rhinopharyngeal mucous membrane may be followed by a parapharyngeal, as well as a retropharyngeal abscess. Although the etiology of both conditions is practically the same, it is our observation that the retropharyngeal type is most likely to occur after the ordinary rhinopharyngitis, while the parapharyngeal type usually follows influenza, tonsillitis, scarlet fever, measles and other infectious diseases.

Occurrence.—Retropharyngeal abscesses occur nearly always in infancy, as the retropharyngeal nodes are supposed to atrophy after the third year of life. Most observers report the occurrence of two-thirds to three-fourths of their cases in children under 1 year of age. The so-called retropharyngeal abscess secondary to tuberculous spinal caries may occur in later childhood, even in adult life; but it is possible that the adult cases described in the literature as examples of true retropharyngeal abscess may have been cases of cellulitis or of involvement of the lateral pharyngeal glands. The parapharyngeal abscesses, involving as they do the lateral lymph chains of the pharynx, are more common after the age of 3, and probably occur more frequently than we suppose, owing to the fact that they may be mistaken for the ordinary retropharyngeal variety.

Symptoms.—The early symptoms of parapharyngeal abscess are those of a mild inflammation of the pharynx, occurring usually in the course of one of the infectious diseases. These may be so slight as

to give no indication of the diagnosis. Then suddenly the temperature may rise to 102 or 103 F. and continue, septic in type, for several days, with no marked local signs apparent. Discomfort, difficulty in swallowing and thickness of speech usually occur. There may then appear a swelling internally just lateral to the tonsil, or externally just below the angle of the jaw and in front of the sternocleidomastoid muscle. There is seldom edema of the uvula or pharynx. The tonsil is seen to be displaced toward the median line. With this exception and the possible appearance of the internal, lateral mass, the pharynx itself may look absolutely normal. The temperature and prostration continue until the pus is evacuated externally, from which time there is, as a rule, an uninterrupted recovery, unless the prolonged illness has exhausted the patient.

Differential Diagnosis.—So-called parapharyngeal abscess must be differentiated from several conditions simulating it, viz.: (1) Retropharyngeal abscess, (2) peritonsillar abscess, (3) interstitial or tonsillar abscess, (4) cervical adenitis occurring in the course of the various infectious diseases.

1. From retropharyngeal abscess. In our opinion, there is little doubt that the variety of abscesses we have styled parapharyngeal, because their site is by the side of, or lateral to the pharynx, exists as a separate entity and may be distinguished from the retropharyngeal type. The retropharyngeal abscess may produce a central bulging, though usually somewhat lateral to the midline; it does not displace the tonsil; it is as a rule accompanied by edema of the pharynx and uvula, by a brassy voice, with the symptoms of more or less laryngeal stenosis, and at times by a retraction of the head. On palpation a distinct cushionlike feeling or fluctuation may be obtained. The parapharyngeal abscess produces bulging nearer the lateral pharyngeal wall, if at all internally, but rarely in the midline; it nearly always displaces the tonsil—and this is a very important point in diagnosis—*toward* the median line, and is rarely accompanied by any marked local change in the appearance of the pharynx, or by any symptoms of pressure on the larynx. In the case of retropharyngeal abscess, internal incision usually cures, unless the suppuration extends to the lateral columns of the pharynx, at which stage the retropharyngeal becomes a parapharyngeal abscess and then requires an external incision, or burrows its way into the mediastinum. The retropharyngeal abscess is usually diagnosed early, while the parapharyngeal abscess may progress for one

or two weeks before a diagnosis is made, or before the external swelling becomes sufficiently prominent to justify an external incision. Of importance also in the differential diagnosis is the age of the patient As the retropharyngeal glands atrophy before the child is 3 years of age, an abscess in this region in a child over this age is more likely to be of the parapharyngeal form.

2. From peritonsillar abscess.

In peritonsillar abscess there is marked redness of the soft palate, and a swelling above and to the inner side of the tonsil, pushing forward the anterior pillar of the fauces. This abscess points within a few days and ruptures spontaneously or requires incision. The tonsil is not usually displaced inward as in the parapharyngeal type; the course is not a matter of weeks, as in some cases of parapharyngeal abscess and there is no external swelling.

3. From interstitial or tonsillar abscess.

These abscesses may follow a severe tonsillitis, involve the tonsils alone, rarely the contiguous tissues, and as a rule do not push the tonsil towards the midline. They cause a marked tumefaction of the tonsil itself, but never an external fluctuating mass.

4. From cervical adenitis occurring in the course of the infectious diseases.

Scarlet fever, influenza, measles, diphtheria, and tonsillitis are often complicated by acute inflammation of the superficial glands of the neck. The glands involved comprise, in practically all cases, the chain known as the superficial cervical glands, although rarely the process spreads to the deeper lymphatic structures. There is as a rule, no suppuration and consequently slight prostration; and lastly there is never any pushing inward of the tonsil—the most characteristic feature of the parapharyngeal abscess.

Treatment.—There is little to be said about the treatment of parapharyngeal abscess, except that repeated internal incisions so often fail to cure, that an external operation with drainage, as soon as the diagnosis is made, is, in our opinion, the ideal method. The rationale of the surgical procedure is evident, if one considers the anatomic relations of the superior chain of the deep cervical glands. The pus cannot burrow its way inward, owing to the resistance of the pharyngeal fascia, nor downward, on account of the dense capsule of the gland,

and consequently it must point toward the plane of least resistance, which is externally, owing to the entrance of the glandular vessels at this site.

Brief abstracts of three cases of typical parapharyngeal abscess operated on by Dr. A. A. Berg follow:

CASE 1.—B. G., aged 4½ years, female. Patient had tonsillitis for several days. After this had subsided the temperature continued high, from 102 to 104 F. for two weeks. The gradual formation of an abscess was observed, which pushed the tonsil inward and produced also an external fluctuating mass. There was mild prostration, thickness of speech, and some difficulty in swallowing. There were no brassy cough, laryngeal stridor or other symptoms of retropharyngeal abscess. After an external operation the patient rapidly recovered.

CASE 2.—R. G., aged 3½ years, male. Three weeks after the onset of a mild scarlet fever, a swelling of the right side of the neck just below the angle of the jaw was noticed. This continued, with fever, increasing difficulty in breathing and swallowing, for one week. The tonsil and contiguous tissues were considerably swollen; the tonsil itself was displaced towards the median line. Internal incision disclosed a slight amount of pus, but afforded only temporary relief. External incision and drainage were then done, with almost immediate relief and permanent recovery.

CASE 3.—A. B., aged 3 years, male. For ten days the patient had an intermittent type of fever, ranging from 101 to 104 F., with malaise, prostration, mild cough, and rhinitis. A diagnosis of influenza was made. At the end of the first week dyspnea, dysphagia, and a swelling on the right side of the neck were noticeable. The pharynx was only slightly reddened; there was no edema of the pharynx or uvula. There was a distinct swelling lateral to the tonsil, which appeared to displace it in the direction of the midline. The external swelling increased in size for several days, until an external incision was made, with evacuation of the pus and a subsequent gradual recovery.

CONCLUSIONS

1. There occurs, especially in children, a form of abscess which is occasionally mistaken for a retropharyngeal abscess, but which has a separate and distinct entity. It may be called a parapharyngeal abscess, as its site is in the lateral columns, that is, by the side, of the pharynx.

2. The origin of this abscess is from the superior chain of the deep cervical glands, which are situated along the course of the carotid artery, as distinguished from the retropharyngeal glands, situated in the circumscribed retropharyngeal space, just lateral to the midline and in front of the prevertebral muscles.

3. These abscesses are as a rule cured only by external operation.

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DISCUSSION

DR. TILESTON: Last fall I saw a case of parapharyngeal abscess which presented in the pharynx at the region of the lateral band on one side. In this case, contrary to what Dr. Heiman states, the abscess perforated internally, and was cured without external incision.

DR. SOUTHWORTH: I think it will require a little closer reading of the paper, when published in the Transactions, to get a better understanding than I could obtain by following the description of the cases when read. It is not clear to me how we are going to distinguish between a peritonsillar and a parapharyngeal abscess. I think that in practice the two are liable to be confused; although, as I understand Dr. Heiman to have said, there is more swelling of the tonsil in the peritonsillar abscess. The external swelling that is noticeable in these two groups of cases, which may be borderline cases, although they are outside of the tonsil, is interesting. There is a peculiar feeling about the external swelling found with these abscesses, which is different from that of anything else. It is a vague swelling, without any particular outline, such as is found when you can feel glands; and it always suggests the presence of an abscess in the throat. Where one finds it, one is liable to see that the tonsillar tissues are pushed over towards the median line.

The cases that might be grouped under one of these two heads, peritonsillar and parapharyngeal, have, in my experience, sometimes been openable inside, and sometimes outside. In one case in which we could readily open the abscess outside, it was possible to pass a probe in and feel it behind the thin mucous membrane of the pharynx. In one that I saw last fall, containing probably an ounce of pus, the opening was made inside; and there was nothing in the way of pointing on the outside. I should like to have Dr. Heiman state, in closing, whether these cases point always externally; and whether, in his recommendation for external opening, he meant that one should go down after them by means of a surgical operation, as one sometimes has to do with the deep cellulitis cases following scarlet fever.

DR. LA FÉTRA: I should like to add my testimony that many of these swellings that occur in the pharynx, on the side, and below the site where the peritonsillar abscesses appear, can certainly be opened from within. Whether Dr. Heiman would include such swellings as I have seen in the class of parapharyngeal abscesses or not, I do not know; but if his statement is that the abscesses must be opened from without, there must be another class—because I agree with Dr. Tileston and Dr. Southworth that many can be opened from within. I have seen many that are not peritonsillar abscesses in the ordinary sense, accompanied by a large swelling on the outside, that can be opened from within.

The second point that I wish to speak of is that, notwithstanding the enormous amount of swelling in the glands of the neck and the pushing over of the tonsil towards the median line, one should not be in a hurry to open these abscesses, because they will frequently subside, if time is given them, and if treated by means of hot irrigations of the throat.

DR. CARR: I think the classification is rather hard to make. A certain number of children may have an infectious process going on both in the deep and in the superficial lymphnodes, and the classification will depend on which group breaks down. At a medical society meeting in New York during which the subject was discussed by pediatricians and surgeons, the surgeons favored

opening externally, and did not consider any other mode of procedure; while many of the medical men thought that they could get relief by means of an internal incision and other methods of treatment, such as irrigations, etc. I believe it is not always easy to anticipate, in a case of this kind, whether it is going to be one suitable for the general surgeon or one that can be managed by the medical man, As, for example, when the swelling occurs in scarlet fever it may be very extensive, and yet wholly disappear with a careful toilet of the nose and throat. The operation to be done, either internal or external, is the one that gives the best drainage, and the physician and surgeon should consider the case together.

DR. GRIFFITH: Dr. Heiman spoke about the diagnosis of retropharyngeal abscess as being easy, but my experience has been that the profession at large are about the last to think of the possibility of the presence of an abscess. The disease is like scurvy in this respect. As soon as the thoughts are turned to it the diagnosis becomes self-evident. Most of the cases of retropharyngeal abscess that I have seen in consultation have been entirely unsuspected by the attending physician. One able physician with a large general practice, with whom I saw a case, said he had never seen such a thing before. Only a few days ago in another case—which the surgeon whom I called in to operate said was the largest retropharyngeal abscess he had ever seen—a physician who had recently been in attendance had evidently never dreamed of what was going on in the throat.

DR. HEIMAN: In answer to Dr. Tileston, who asked whether it was possible for a case of this description to rupture internally I wish to say that this may occasionally occur. When we consider that we are dealing with the upper glands of the superior chain, we can see that if these become infected and point towards the pharynx, pushing the tonsil inward, the abscess may rupture and the patient recover without operation. If you look at the plate, you will find that this is possible. In my conclusions I said that these abscesses are, as a rule, cured only by external operation. That does not signify that every case requires a radical operation.

In answer to Dr. Southworth's question regarding the differential diagnosis between a peritonsillar abscess and a parapharyngeal, let me repeat that a peritonsillar abscess, as a rule, follows a tonsillitis; and that the symptoms are usually sudden in onset. The condition develops rapidly, within two or three days; whereas, it requires weeks for them to develop in the true parapharyngeal abscess. Often, the only way by which we can tell that anything is wrong in the case of the parapharyngeal type is by observing that the temperature remains high and septic in type. Then we suspect the cause of the trouble, and look at the tonsil closely; and we find it pushed inward, without any apparent local redness. Whereas, anyone seeing the peritonsillar abscess, will, within twenty-four to forty-eight hours, be able to make a diagnosis of it. It also pushes forward the pillars of the fauces.

Dr. Porter asked how to make the differential diagnosis between a superior cervical adenitis and a parapharyngeal abscess. In my paper I stated that the superficial glands are sometimes involved in infectious diseases; but these abscesses point entirely outward, and the tonsil is never pushed inward towards the median line.

Dr. La Fétra expressed his belief that cases can be opened from the inside. I fully agree with him that if the upper glands of the superior chain are involved. these abscesses may drain well from above downward.

Dr Carr said that the localization of the abscess will depend on whether there is a broken-down node in the deep or the superficial chain, and that one cannot always tell whether the case is one for the surgeon. This can usually be determined by observing whether the patient improves with the ordinary mode of treatment or not.

Dr. Griffith says that it is often difficult to diagnose retropharyngeal abscess. That is true; but in my opinion these cases are sometimes overlooked because they are not looked for. When I first heard of amaurotic family idiocy, the case presented was supposed to be only the seventeenth case on record. This was in 1897; but within a year's time, there must have been thousands on record. If we think of, and look for these abscesses, whenever there is trouble in the throat of a child, I believe that we shall be able to diagnose them more frequently.

A CONTRIBUTION TO DUCTLESS GLAND THERAPY

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The contribution which I have to make has to do with the action of the pars intermedia of the pituitary gland. These particular activities of the gland, from a therapeutic standpoint, have become apparent through a study of an abnormal child carried on for the past two and a half years by me, and previously by several physicians connected with the dispensary of the Babies' Hospital, including Drs. Kerley and Van Ingen.

The patient was seen first on Sept. 1, 1905, at the age of 3 years and 8 months, when a diagnosis of cretinism was made on a history that she did not walk nor talk and on the presence of coarse, thick hair, an open mouth, a lolling tongue, short thick thighs, a fontanel of 1½ by 1½ inches and a weight of 27½ pounds.

Given thyroid in small doses, she gained rapidly and steadily in weight and height and intelligence. In seven months she was walking and talking and was regarded as very mischievous. At the end of two years' treatment she was bright and intelligent with a closed fontanel and a not greatly protuberant abdomen. Enuresis was noted toward the end of this period.

Shortly after this it was noted that she was not so bright and the dose of thyroid was increased somewhat. She wet the bed a good deal and her skin had a tendency to break out and to be rough. Still she made good progress in weight and height, reaching 45½ inches at 8 years (January, 1910) and 56½ pounds.

At this time she came under the direct charge of an assistant who was an enthusiast who regarded her slowness in mental progress as an evidence that she needed more thyroid, and who proceeded to increase her dose successively from 3 grains a day, the maximum up to then, to 4, 6, 9, 10 and even 15 grains of B. W. & Co. thyroid a day. She had 10 grains a day during the entire year 1912.

This increase of thyroid was not productive of mental improvement, and it did result in an immediate loss in weight and a subsequent development of signs of hyperthyroidism already foreshadowed, perhaps in the enuresis and tendency to rashes, particularly scabs about the nose. She became nervous, irritable, of a poor memory, wet the bed every night and the mentality became even duller.

When she came under my direct care in February, 1913, she was 11 years old, a large child, a little shorter than the average, and a little above average weight. She was dull in school and could not pay attention. She wet the bed every night. She was very nervous and irritable, and had an ugly temper. Her nervousness had reached such a degree as to amount to a positive tremor which had been suspected to be chorea. This prevented her using pen and ink. Her appetite was excessive—she ate all the food that she could lay her hands on—one morning she ate eight rolls for her breakfast.

Her pulse was 120. There was no heart murmur. She weighed 73 pounds and measured in height 53½ inches in stockings.

It was apparent that she was suffering from too much thyroid, as both the dosage and her symptoms showed. It was decided to omit the drug for a time, instead of merely diminishing the dose. This the mother consented to do, although a little reluctantly, because she had been instructed never to let any one stop giving the child thyroid.

By the next visit we had been rewarded by one dry night and steadier nerves. In a month she had wet only three nights. In six weeks, she was not at all nervous, and did not wet at all. Her weight had increased 10 pounds in this interval.

Because her color was grayish, and because it was feared that some injury might follow too long withdrawal of the thyroid, she received 2½ grains (now known to be plainly too much) for two weeks. She wet the first night it was resumed and in two weeks had lost weight. Thyroid was again withdrawn and kept withdrawn until the fall of 1913.

During the spring and summer of 1913 she improved rapidly, becoming much brighter in school, less irritable, livelier in disposition. She began to pay attention to things she had never noticed before, such as remarks made around her. She learned to read and could no longer be fooled by spelling out words. She began to write with pen and ink, which she could not do before because of tremor.

Her appetite became normal, and while still very good, it was quite easily satisfied. Bed wetting became a lost art.

Along with her remarkable gain in weight, which will be noted on the chart, was the development of the breasts, first noted in June, 1913, and a little hair on the labia. She seemed remarkably normal in every way except that she showed some of her cretinism in her shortness, her lordosis and her prominent abdomen.

In September, 1913, occurred another attack of poor appetite and grayness such as had occurred a month after withdrawal of thyroid. This disappeared promptly with calomel and rhubarb and soda, without thyroid.

However, later in the fall, an attempt was made to improve her condition of slowness, which seemed to be increasing, by giving a preparation of thyroid gland made by Dr. Kendall, then working at St. Luke's Hospital. It was noted that she had become a heavy sleeper, difficult to rouse. She was slow in her motions, which may have had some relation to her greatly increased weight. Her skin was thickened with what looked like the thickness of myxedema, but her color was good and her expression intelligent. Dr. Kendall's preparation "B" was supposed to affect particularly the skin and the intelligence. She had this seventeen days, when the supply ran out and no more could be obtained, as a lot of thyroid obtained from a large pharmaceutical house gave a "B" which was quite inert. This was attributed to bacterial action in improperly kept glands. This drew my attention to the necessity of having absolutely fresh glands and immediate desiccation.

In January, 1914, she began to show definitely the symptoms which we came to call "acromegaly."

During the whole of the preceding six months, at least, it seemed that some other agency had been set at work or released by the withdrawal of the thyroid, because her weight had increased so rapidly and her general bigness, although her height had not.

She now had gained 10 pounds in four months, and almost nothing in height. She looked very chunky; her face was of a heavier cast; she looked older and sullen. Her hands were broad and the fingers blunt. To investigate the possibility of pituitary involvement, her wrist and her head were radiographed and her tolerance for glucose determined.

The sella turcica was enlarged, the antero-posterior diameter being 14 mm.; the depth 9 mm. (Normal adult of same size head A.P. 10.8, D. 7.7.)[1]

The wrist seemed practically normal for her age, which was surprising considering her cretinism.

By mistake, when we came to test her tolerance for glucose, she received 250 gm. instead of 150 gm. Yet she retained it, showing no glucose in the urine.

Acting on the assumption that an increased tolerance for glucose meant a deficient pars intermedia secretion, we concluded, rightly or wrongly, that there was a hyperplasia of the pars anterior causing enlargement of face, hands and feet, and that this might have, by pressure on the pars intermedia itself, or its blood supply, caused its secretion to become deficient. This hypothesis is strengthened by analogy with the pituitary of pregnancy, and by Cushing's statement that an enlarged anterior lobe may exert pressure on the posterior lobe, disturbing its secretion. It was determined to act on this.

A preparation of pars intermedia was obtained in capsule form, each capsule being the equivalent of 150 pounds of live bullock. This preparation has the merit of being dried and made stable within forty-five minutes of the removal of the pituitary from the slaughtered animal. It is mixed with milk sugar and will keep in the cold a year. There is no pars posterior (nervosa) included in the preparation.

Before this was administered, a photograph (Fig. 1) was taken showing the child about March 20, 1914. This shows pretty well her peculiar appearance. She looks more like a little ugly young woman than a child of 12; her face is heavy. The squareness of her figure is accentuated by the prominence of her bust. Her skin was thick and solid, particularly over thighs, buttocks and abdomen. Her complexion had taken on a yellow cast. The skin around her finger nails was scaly, and the skin generally was rather cold and not pleasant to the touch.

She was slow in her motions; a heavy sleeper and hard to waken. She was eager to play, but much slower than other children. She seemed to be learning music, which she loves, and was very apt at learning all the modern dances which she dances well. She was clever with her needle and could trim hats. School work did not go very well. She weighed 106½ pounds and was 54½ inches tall.

After two weeks of capsules, it was noted that the expression was brighter, as if something had lifted from her countenance; her mouth was more closely shut and she said "Hello" briskly when she entered the office. More noticeable was the increased smoothness of her skin and its thinning, which enabled one to pick it up easily, which could not be done previously.

In a month her face had lost its vacant, sullen look. Her skin had improved. She seemed more slow than ever about getting up and about. This may have been due to her increased weight, which had gone to 108 pounds. This increase may have been due to successive attempts to test her tolerance for glucose, which usually resulted in vomiting. Later it was noticed that the weight increased noticeably after these ingestions of glucose—more than the weight of the ingested glucose.

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1. Potts: Jour. Am. Med. Assn., Sept. 27, 1913, p. 1188.

The capsules were continued. By July it had been noticed that in addition to the change in facial expression and skin, there had been a distinct change in the contour of her hands. The fingers became tapering where they had been blunt, distinctly more pleasing to the eye and the touch. Her hips were more slender and shapely; the lower extremities were straighter and the ankles could be brought closer together. The skin was soft and the hair more oily. Her breasts were larger, there was more pubic hair, but no menstruation. Her complexion was pink and white. She had become quick at repartee, but was still a heavy sleeper and routine school work was difficult.

By October she had improved a little in waking. The use of adrenal for two weeks did nothing, while the omission of the capsules of pars intermedia caused a return toward a yellowness and roughness of the skin. She was still slow on initiative, and it was determined to introduce thyroid without the capsules to see its effect.

After three weeks on thyroid gr. 3 to gr. 1, she had lost 3½ pounds; her skin was drier, and her hands a little more blunt, but she seemed keener intellectually, got up of her own accord and had become very talkative.

Pituitary was resumed, 1 capsule and gr. 1 of thyroid, and continued until Feb. 24, 1915, a steady improvement taking place in skin, contour—the hips were very slender and for the first time in a long while she could put on and button an ordinary shoe without setting the buttons over. A photograph was taken then because it was determined to stop the pituitary while continuing the thyroid to see if the pars intermedia was really necessary.

Mentally she had become more alert—she had become an expert dresser, although precipitate in undressing; was fond of reading—such books as the "Five Little Peppers" and the Alger books. She was very inquisitive, and clever enough to be away at dish-washing time. Had become conscious of self—began to care what she had to wear and show some speculative faculty. She said once: "I wonder what I would have been if I hadn't gone to him" (the writer).

Pituitary was omitted until April 13, six weeks, and then a third photograph was taken. While well and retaining her improved figure, there was a certain heaviness of face that had crept into her look and her complexion was yellower, her skin rougher on back of arms, thighs and buttocks. Her fingers were a little blunter. She was slow in her movements.

This experiment was particularly interesting, because when she came to see me on March 16 I had not ordered her to stop pituitary, but contemplated doing so at that visit. When I saw her, I thought she was sick and immediately gave up the idea of doing so. It transpired that the undoubtedly more sullen expression, the yellowness and the thickened face, was due to her mother having stopped the capsules according to what she thought I had directed two weeks before. I felt my judgment sustained by this accident.

Since this time she had had one to three capsules a day and there had been marked and rapid improvement again, in all the characteristics which seem to be affected in her by the pituitary. There has been general improvement in color, clearness, whiteness and smoothness of skin, which feels warm and pleasant to the touch. Even around the nails it is good.

The changes in symmetry are particularly noticeable, as before when taking capsules, the slope of shoulders, slenderness of waist, slenderness of hips, thighs, legs and ankles and straightness of lower extremities. There is less protuberance of abdomen and her lordosis is less marked. The hands seem lower

down toward the knees. Her sisters think she has grown taller, but it is only an inch.

To any one who has seen her, she does not appear to be an abnormal child, only a rather heavy, stocky one, very good natured and not sensitive to pain.

Miss Keller, who tested her for intelligence by the Binet-Simon card, remarked on her wonderful complexion.

Her blood pressure now is 100 systolic, diastolic, 70; pulse rate, 72.

She still has a tolerance for 150 gm. glucose.

Her blood sugar (which Dr. Schloss was good enough to determine) is 0.58 per cent.; 3½ hr. p. c.

Her intelligence registers about 9 years, but this is to be qualified by the possibility of an imperfect pedagogic method, inasmuch as she does not attend a special school.

Roentgenogram of sella May 19 shows A.P. 15 mm., D. 9 mm. (this may be distorted).

Roentgenogram of wrist now shows the pisiform.

Photograph, Figure 3, speaks for itself. She has not menstruated.*

A provocative injection of 0.5 c.c. pituitrin (P., D. & Co.) into the subcutaneous tissue of the right arm following the ingestion of two capsules and 150 gm. glucose produced a faint trace of sugar in the first six hours' specimen following injection.

It seems evident in this case, that, assuming a deficiency of thyroid as evidenced by the condition when first coming for treatment, there is also an affection of the pituitary; that this affection of the pituitary partakes of the nature of a deficiency of the pars intermedia, whether or not one is ready to assume an overgrowth of the pars anterior, and that the exhibition of pars intermedia has improved the condition in unexpected ways.

The questions of whether the pituitary has always been at fault, or whether the overdosing with thyroid has affected it, or the withdrawal of thyroid has simply allowed it to assume an activity, are subjects for pleasurable speculation. I cannot feel certain about it, although as the pituitary symptoms developed, it looked as if they came out from behind a withdrawing curtain of too much thyroid.

It seems evident, also, that the hypothesis on which pituitary medication was started has, as I have indicated, some probability.

The secondary sexual development would seem not to be due to pituitary directly, but to the effect of disturbance of that gland on the interstitial cells of the ovary, known to be closely associated with the pituitary.

There are no neighborhood symptoms and no evidence of tumor.

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* Menstruation appeared in June, 1915, was profuse, continued a week and was accompanied by a fair amount of pain.

The effect of thyroid during the past three years seems to have been confined, so to speak, to setting the pace for her initiative, and also in clearing up the scaly skin about the finger nails, although before thyroid was resumed, there was some evidence of benefit in both these conditions under pars intermedia.

The effect of the pars intermedia on the mentality was no less striking than it was unexpected. Perhaps we should say "on the disposition," for the intellectual changes took place to a large degree simply from withdrawal of thyroid, and its present continued low standard may be due somewhat to the child's being in a graded class. However, in liveliness of disposition, sweetness of temper, general interest in things, and a sense of personality, the pars intermedia therapy has seemed to have great effect.

It has been remarkably interesting in following the unfolding of this case to see

1. Symptoms which might rationally have been considered to be due to hypothyroidism clear up with the exhibition of pars intermedia;

2. The remarkable effect which the exhibition of this lobe had on the smoothness, texture, and color of the skin and its warmth;

3. The striking changes in contour of hands, ankles, hips, shoulders, thighs, buttocks, etc., changes which could be made to come or to recede with the giving or taking away of the gland.

I am aware that in the consideration of this case we have come but part of the way, and that it will be necessary to investigate other glands before a final conclusion can be reached. It has taken me a year to determine to my satisfaction the value of and the necessity for the pars intermedia and the essential slowness of the method must be my apology for any incompleteness.

CLINICAL NOTES

F. L., aged 3 years 8 months. Family history negative. No miscarriages. Whooping cough previously. Nursed ten months. Now having general table food.

Sept. 1, 1905: Brought to Dr. Kerley's Clinic at Babies' Hospital Dispensary because baby does not walk or talk. Hair coarse. Thighs thick and short. Mouth open. Tongue out. Diagnosis, cretinism.

September 6: Fontanel 1½ by 1½; weight, 27½ pounds. Having thyroid extract ¼ tablet (? amount) t. i. d. Baby sleeps better.

September 13: Uses eight more words than she did. Is more playful and brighter. Stools normal. Weight, 28½ pounds.

September 20: Increasing in disposition to talk. Plays better, but seems somewhat restless. Thyroid ¼ tablet b. i. d.

September 27: Vocabulary increased by four or five words. Still a little restless. Bowels more regular. Mother thinks child much brighter. Speaks about thirty words. Weight, 28 pounds.

October 4: Had an attack of vomiting and diarrhea; mental condition shows no change. Thyroid gr. ½ b. i. d.

October 18: Vocabulary increasing. Seems brighter. Continue treatment with addition of lard inunctions and salt baths. Weight, 28 pounds.

November 1: Doing well. Weight, 28½ pounds.

November 15: Much brighter. Puts two words together. A little constipated.

November 22: Yesterday used four words together. Weight, 29½ pounds.

December 13: Improving steadily. Talks much more fluently. Fontanel, ½ by ½ inch.

Jan. 17, 1906: Aged 4 years, December 30. Adenoids and tonsils taken out at 3½ years. Is still improving, though more slowly. Words are spoken quickly. Tongue protrudes less. Is brighter and more cheerful. Still constipated. Thyroid to be gr. ½ t. i. d. Weight, 31½ pounds.

March 28: Walks, talks, plays and is very mischievous. Fontanel closed. Tongue in mouth. Mouth still open a little. Legs are straightening. Weight, 32¾ pounds. Height, 35½ inches.

November 23: Tongue is not large. Teeth are poor. Legs are almost straight. Liver and spleen are not felt. Is bright and intelligent. Abdomen is much less prominent. Fontanel closed. Much incontinence. Atropin gr. 1/200 ON OM. Weight, 39 pounds. Height, 38 inches. A. S. S. to internal malleolus, 17⅛ inches, Acromion to tip middle finger, 14 inches. Circumference head, 21⅞ inches. Circumference chest, 21½ inches. Circumference abdomen, 20 inches.

Jan. 16, 1907: Continue treatment. Height, 38 inches.

September 20: Height, 39 inches.

November 20: Much improved in the past three months. Talks better. Is brighter. Teeth very bad. Height, 40 inches. Weight, 48½ pounds. Circumference of head, 22½ inches.

July 11, 1908: Doing fairly well, but mother thinks she is not quite so bright. Increase thyroid from gr. 1½ to 2 a day. Still is constipated.

October 7: Goes to school. Seems to be in very good condition. Height, 42 inches. Circumference of head, 22½ inches.

Jan. 20, 1909: Had measles. Thyroid was stopped for one week. Was very dopey after one week without thyroid. With resumption of thyroid picture cleared up. (A later story tells that child had very severe measles and was practically comatose during it and the physician in attendance regarded the withdrawal of thyroid as concerned in producing her bad condition.)

April 2: Has not seemed as bright lately. Mouth is open all the time. Adenoids are felt. Increase thyroid to gr. 2½ a day.

Jan. 10, 1910: Doing well. Height, 45½ inches. Weight, 56½ pounds.

November 21: Not so bright. Is getting thyroid, gr. 3 a day. Increase to gr. 4. Skin is rough and there are some sores on nose. Used unguent-salicylic acid to arms and body.

Nov. 25, 1910: Skin same. (Change of doctors to an enthusiast.)

May 12, 1911: Memory poor. Poor pupil at school. Still has enuresis. Increased thyroid to gr. 6 a day. Weight, 59¾ pounds.

June 7: Went one night without urinating. Adenoids by palpation. Increase thyroid to gr. 9 a day.

June 28: Scab on nose returns. Urinates frequently. Diminish thyroid to gr. 6 a day.

Sept. 18, 1911: Very nervous. Go to thyroid gr. 4½ a day, with potassium arsenite, gr. 1/100 t. i. d.

Jan. 29, 1912: Enuresis pronounced. Backward at school. Bulimia. Thyroid to be gr. 5 b. i. d.

February 14: Reduce schooling. (About this time according to mother, patient received thyroid gr. 15 a day, B. W. & Co.)

September 18: Nervous. Getting thyroid gr. 5 b. i. d.

Feb. 26, 1913: (Enthusiast resigned.) Now aged 11 years. Large and growing well. She wets the bed, however, every night. Very nervous and irritable; has ugly attacks. Nervousness amounts almost to a tremor. Appetite excessive. Often eats all the food on the table (one morning ate eight rolls). Has been thought to have St. Vitus' dance. Dull in school; cannot pay attention. Pulse 120. No murmur. Weight, 73 pounds. Height, 53½ inches. Stop medicine two weeks.

March 12: Not quite so nervous. Didn't wet last night for first time. Continue. Weight, 77½ pounds.

March 26: Wet two out of fifteen nights (best in years). Not nervous now.

April 9: Is not nervous and does not wet at all. Appetite is fine. Resumed one-half 5 gr. tablet a day. Weight, 83¾ pounds.

April 23: Wet once, the first day of taking thyroid. There seems to be no difference except skin, which assumed a grayish cast at last visit, but now is clear again. Is much brighter in school and much livelier since the thyroid was stopped first. Before this did not pay attention to remarks, but now is keener than the others. Again omit thyroid. Weight, 83¼ pounds. Height, 54 inches.

May 7: Seems very well indeed. Color is all right; just as good without thyroid as with it. Does not think of enuresis any more. Weight, 84¼ pounds.

May 21: Seems O. K. Never thinks of wetting. Now going a whole day to school, which tires her somewhat. Weight, 87 pounds.

June 4: All right in every way. Now eats rationally.

June 18: Body examined. Arms go down 7/15 of distance to knee from anterior superior spine. Shows signs of maturing. Breasts are becoming prominent and there is a little hair on vulva (between labia). Is progressing with her reading and can no longer be fooled by words spelled out. Writes well and with ink, which she could not do formerly because of tremor. Weight, 89½ pounds.

July 16: All right in every way mentally. Appetite quite easily satisfied. Weight, 91 pounds.

August 11: Fine. Continued without thyroid. Weight, 94 pounds.

September 10: Has been ill for four or five days. Has had no appetite and color has been poor. The color resembles the condition in April when thyroid was resumed with the idea that its absence made color poor. Stools and urine not noted. Gave calomel gr. 2 and rhubarb and soda. Weight, 93 pounds.

September 22: Was all right after calomel. Weight, 96½ pounds.

Jan. 27, 1914: Since last note patient has not been seen so frequently, as she was doing well, growing heavier and apparently holding her own mentally. She has, however, been growing very slow in her motions and inclined to lie abed. She is also hard to waken. Her flesh is hard and rather thick. Her color is good and she has an intelligent expression. With the idea that she must need some thyroid, although she seems to do well without it, she

has been given for seventeen days capsules of Dr. Kendall's thyroid "B" which is supposed to stimulate the mentality and lessen thickening of the skin. She wet her bed first night of taking this, but this may have been accidental. Her appetite has been better but she is very slow. She has been more talkative in school. She looks very much heavier than when last seen and her facial expression is different. She looks older, rather sullen and heavy—a leonine expression. She skates well but is slow in getting started. She is a splendid sewer and very ingenious at this. Weight, 106 pounds. Height, 54½ inches. Continue without medication. Have roentgenogram of sella turcica and test sugar tolerance.

February: Roentgenogram shows enlarged sella turcica.[2] A. P., 14 mm.; D., 9 mm. Wrist shows practically normal ossification for age. Pisiform nucleus just beginning to show. Test for sugar tolerance. By mistake, patient took 250 gm. glucose instead of 150 gm. Urine examination normal; no sugar. General condition about the same, a large, notably well-developed (secondary

Fig. 1 (Series 1).—Author's patient, taken March, 1914.

sexual characteristics) girl, of pleasant disposition, very chunky and solid, with a stolid expression and a skin which is thickened and of a yellowish cast, not a cretinoid type. Pituitary?

March 19: Child has been getting more peculiar in appearance. Looks like a little ugly young woman rather than a child; face is heavy and sullen; lips rather thick, nose stubby; neighbors say she looks older. This is accentuated by the development of her bust. Skin is thick, particularly over thighs, abdomen and buttocks. Seems to be due to a deposit of subcutaneous fat, for the skin is somewhat nobby like a stretched lipoma but there are no localized fatty tumors. Hands are broad, with stubby fingers and the skin around the finger

2. Potts: Jour. Am. Med. Assn., Sept. 27, 1913, p. 1188. Average of forty-one normal adult sellae: A. P. 10.8; D. 7.7; maximum 16; D. 10. Children, 12 years, A. P. 7, D. 10; 6 years, A. P. 8, D. 6; 4 years, A. P. 7.5, D. 7; 15 years, A. P. 10.5, D. 7.

nails is scaly. Skin over elbows thick and scaly. Occasionally flushes and has a good color. Is very strong. Appetite good, not excessive. Weight, 106½ pounds. Height, 54½ inches.

Disposition is happy, usually, but has sullen fits and ugly fits. She is fond of reading which she has learned to do since February, 1913. She seems to understand what she reads.

Sleeps well; very hard to wake; goes to bed early. Is eager to play but is a little slower than other children. Loves music and seems to be learning this. Dances well—can do all kinds of modern dances and learns these quickly and better than anything else. Is clever with needle and can trim hats. Will not take cold water baths now. (This was thought due to poor circulation of skin, which feels rather cold and unpleasant to the touch.) (Fig. 1.)

Is to have capsules of pars intermedia of pituitary prepared by Mr. Perry.[3]

April 6: Has been taking pituitary capsules for two weeks. Weight, 106 pounds. Height, 54½ inches. Expression is a little brighter. Said "hello" briskly when she came into office. Mouth shuts a little better. More noticeable is the increased smoothness of the skin and "thinning" over the lower thorax. Still doesn't wake up unless shaken. A slow dresser. Continue.

April 22: Face has lost vacant, indifferent leonine look. Expression brighter. Still awfully sleepy in morning. Lazy; does not want to walk. (Due to weight?) Appetite O. K. Bowels more or less constipated. Skin has improved. Skates well when she gets started. Seems worse than ever about coming when called. Weight, 108 pounds. Urine not so abundant. Attempt to test sugar tolerance difficult because of tendency to vomit; 150 gm. glucose not followed by any glucosuria. (May weight be due to several attempts with glucose?)

May 25: Had indigestion at time of trying tolerance. Vomited glucose five times. Has been taking capsules for two months. Out of them last few days. Expression shows improvement. Skin shows improvement. Is just as heavy a sleeper. Begins to take her own part against others and "scraps." In play has not initiated anything; still slow. School work still not good, and she talks a good deal and gets poor deportment marks. Breasts continue to enlarge and the hair on vulva to become longer and thicker. No menstruation. Appetite is not so good; just over indigestion; bowels more or less constipated; gets medicine every Friday night. Blood examination (figures lost) showed nothing abnormal in differential. Specimen of urine one week after

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3. *Preparation of Pars Intermedia Capsules.*—The material is collected at the abattoir on the morning of killing. The fresh pituitary gland of the bullock is taken to the laboratory within fifteen to thirty minutes of the killing. The pars intermedia is dissected off and dried at once, the drying being completed within forty-five minutes. It is mixed with milk-sugar and the finished product in capsules may be ready within one and a half hours after killing. The pars posterior is not included. Each capsule represents as nearly as possible, the pars intermedia of 150 pounds of live bullock. These capsules will keep in the cold for a year. The great essential is promptness in drying after removal of gland, as bacterial action may destroy the active principles in a very short time. Any preparation made from glands kept in cold storage or as much as twenty-four hours old will probably be much less efficient if not inert. Dr. Kendall's preparation could not be continued because he ran out of his first lot, and a second supply made from another lot of thyroid—somewhat old—was inert.

stopping capsules showed no glucosuria after 150 gm. glucose. She stands up straighter and has grown ⅝ inch. Weight, 105 pounds. Height, 55¼ inches.

Two observers independently have noticed a change in her hands, which is apparent today. Hand has a less heavy, blunt look. Fingers are more tapering. Hand is distinctly more pleasing to the eye and skin is softer. Nothing detected about feet. There is a change in the lower extremities; legs are more approximated; not so great a deviation; ankles can be more nearly brought together. Complexion not so yellow, in fact almost pink and white. Disposition pleasanter; not sulky; takes and gives jokes. Resume capsules.

July 6: Tanned. Appetite good but not too good. More or less constipation. Sleeps well; waked a little more easily. Plays actively; cannot yet keep up with other children, but does not mind. Initiates games and roller skates faster. Laughs easily and is very quick at repartee, which is a great change. Not much change in school work. (Goes to a parochial school where the pedagogic method may not be adapted to her.) Skin is nice and soft. Hips are more slender. Hands better shape. Hair more oily. Breasts larger. Hair on pubes. Legs are hard as iron. Abdomen still pendulous and lordosis noticeable. Bicuspids said to be abnormal. Teeth are generally good.

October 2: Has not had any pituitary for two weeks. Took it all summer during my absence, working it up to four capsules a day once when she had a month of rather bad temper. Is talkative and inattentive in school. Has been promoted but finds all day hard. Skin is still good, but face is a little heavy. Wakes much more easily. Breasts well developed. Hair has increased. Blood pressure, systolic, 90; diastolic, 50; pulse rate, 84. Weight, 106¼ pounds. To try what effect, if any, adrenal has. Tabloid adrenal gr. 5 O. D.

October 23: Skin yellow, pimply. Not so well. Stop adrenal. Give thyroid B. W. Co. gr. 3 a day. Sphygmomanometer out of order.

November 7: Been on thyroid gr. 3 a day. Height, 55½ inches. Weight, 103 pounds. Is brighter and quicker. Skin is drier then when taking pituitary. Look is keener and more thoughtful; not so indifferent and smily. Hands are less tapering than they were last June.

November 14: Look is more straightforward. Gets up of her own accord. Sews a lot and has considerable initiative. Likes to read a lot and to be alone. Very talkative since taking thyroid. Arithmetic her *bête noir*. To have gr. 1 thyroid b. i. d., and one pituitary capsule.

November 28: First five nights on which she took two medicines she wet four times (first in about a year). Mother thinks she has improved. Gets up better. Not brighter in school. Still talkative. Wants to go out more. Pulse, 100. Weight, 103 pounds. Height, 55 inches. Skin again soft and smooth. Continue.

December 12: Better than she has ever been. Brighter. Color better. Expression is best yet; intelligent and thoughtful. Plays actively; is not now always the last one. But is inattentive in school. No wetting. Weight, 102¾ pounds. Skin has improved; even on belly it is softer, smoother and thinner. Hands taper. Hair on pubes same. General figure is slenderer.

December 18: Has wet five out of six nights. Not so good tempered and possibly not so bright. Color not so good this week. Pulse, 84. Blood pressure, 90-50. Weight, 101½ pounds. Stop thyroid one week. Continue pituitary. Glucose, 100 gm.; had tolerance for this.

December 29: Tomorrow aged 13 years. Has had a cold. Color was not quite so good a week ago; better now. Does not seem quite so fine as when she got thyroid gr. 2 and one capsule, but weight is better and has not wet bed.

Has become very inquisitive in the last couple of weeks and notices things she would never notice before. Appreciates things better. Initiative still increases. Does not want to be alone so much. Plays well. Is more self-conscious than formerly. Begins to care what she has to wear. Has more individuality, which is shown also in expression of face; is more thoughtful and more aware of being an individual. She has always been sympathetic. Her movements are very decently active and alert. She dresses herself quite expertly and is precipitate in undressing. Is very strong physically. No menstruation. To have gr. ½ B. W. thyroid a day. One capsule pituitary. Weight, 102½ pounds. Height, 55½ inches.

Jan. 14, 1915: For the first few days on gr. ½ thyroid was ugly and general color was not so good. Mental condition about the same; is a little slow in getting ready for school. Appetite good; eats plenty. Fingers are quite normal.

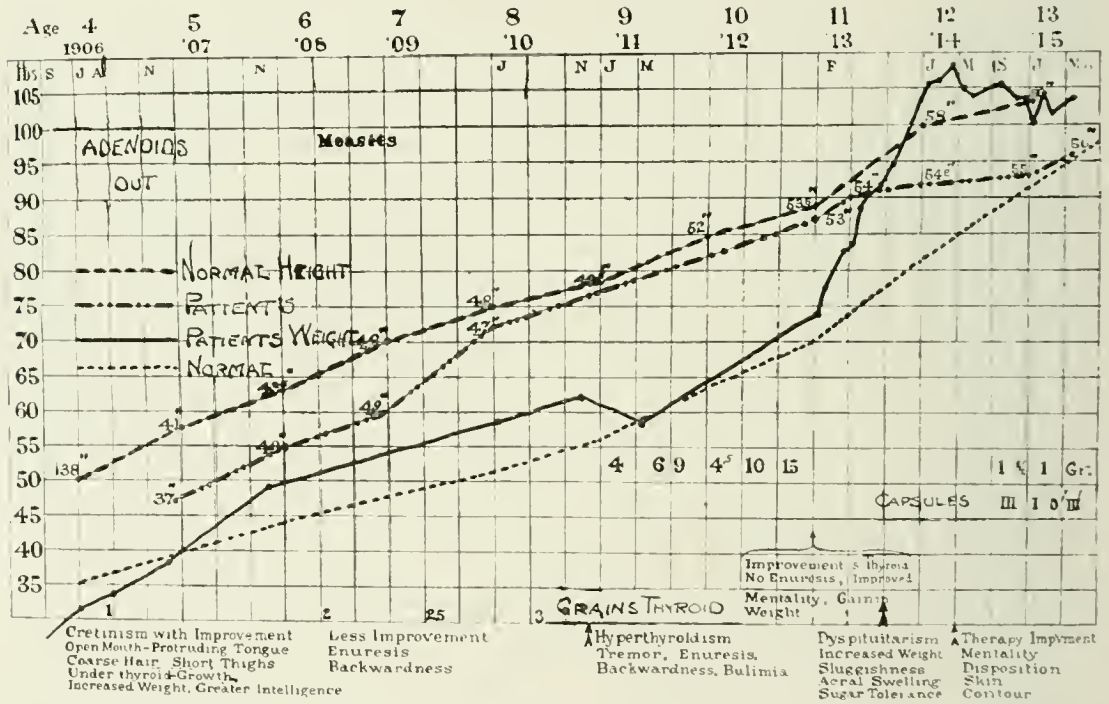

Fig. 2.—Chart showing patient's progress in weight and height with thyroid, with excessive thyroid, without thyroid, with pituitary alone, and with pituitary and thyroid. Also indications as to change in mental characteristics.

Hand is noticeably of nice contour. For the first time ankles can go into an ordinary shoe without changing buttons. Weight, 104¾ pounds. Height, 55½ inches.

January 29: Does not look so well as last time. Nails are again scaly. Weight, 103½ pounds. Give gr. 1 thyroid a day and one capsule pars intermedia. Photograph by Dr. Kilmer (Series 2).

February 24: There is a noticeable change in figure toward slenderness and normal contour. Said to have "a shapely figure." Skin is very soft and smooth except a little at finger tips. Face has a good expression of quiet intelligence. Pubic hair is quite abundant. Breasts large. Lordosis not so noticeable. No wetting. Bowels constipated (to have cascara).

Mathematics still a stumbling block; is much better at dressing; gets up more willingly; plays well and keeps up with the others at play. Still inattentive at school. Nice whistler and dancer. Very fond of reading such books as "Five Little Peppers" and the Alger books. Very full of questions. Clever enough to be always away at dish-washing time. Shows some imagination. Said, "I wonder what I would have been like if I hadn't been going to him" (Dr. Haynes). Pulse, 80. Head, 22½ inches. Chest, 28½ inches. Trochanters, 34. Weight, 103 pounds. Height, 55½ inches. Here planned to stop pituitary to see if it really was necessary and had done what it had been thought to do. Not ordered stopped.

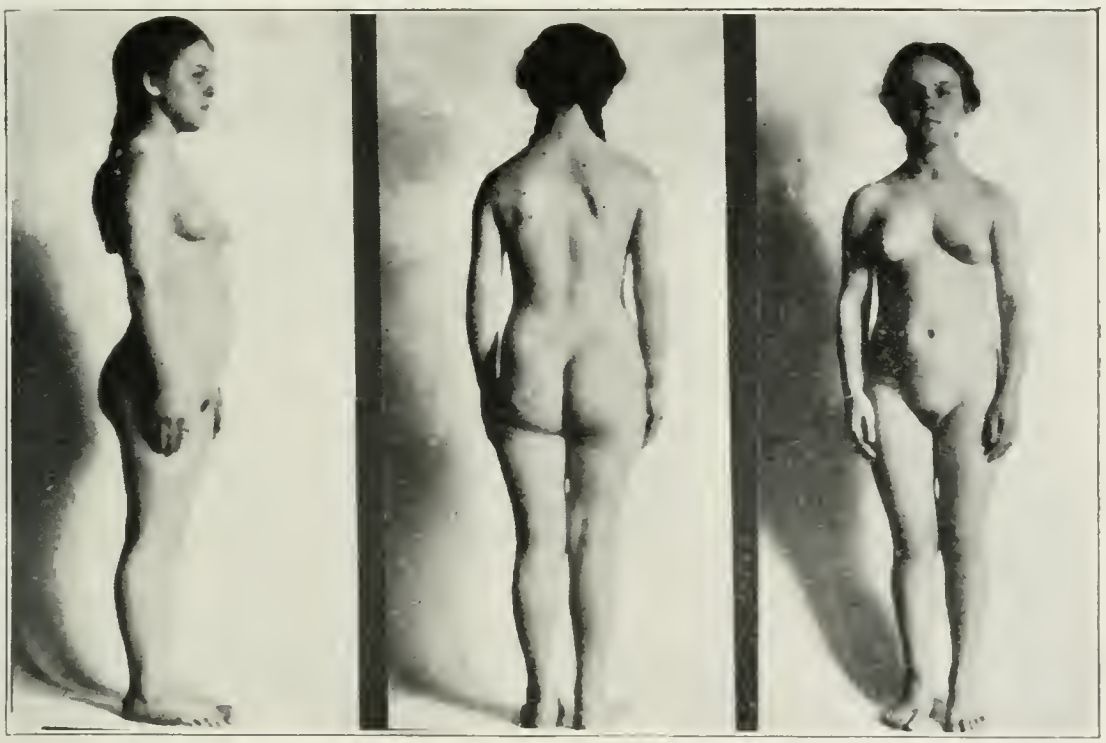

Fig. 3 (Series) 4).—Taken May, 1915. Had been receiving one to three capsules a day, and 1 gr. B. W. Co. thyroid since April 13.

March 16: When she came into the office she seemed sick in some way which was determined to be a more sluggish expression and a yellower color and slightly swollen face. Determined not to stop pituitary yet, when mother told me that she had understood me to say stop it and had done so two weeks before. Face distinctly heavier; skin rougher on hands, arms, back, and buttocks. Face pimply. Anterior surface of body about same. Curvature of back more like first picture. Has been sullen and irritable. Continue without pars intermedia capsules.

April 1: Still without pars intermedia. Skin roughened in spots, particularly back of arms, thighs and buttocks. Laugh seems less intelligent; said to talk sillier things. Hair on pubes increased. Breasts larger and patient is aware of them. Apropos of their prominence said, "I know I am going to have children when I grow up." No axillary hair. Hands blunter.

April 12: Still without pituitary. Having thyroid, gr. ½ b. i. d. Is cross and ugly. Face heavier. Looks heavier in motions and figure is less symmetrical; rather clumsy. (Series 3.) To have 150 gm. glucose. Tolerance. Resume pars intermedia capsules after test.

May 5: Has had two capsules of pars intermedia a day and 1 grain of thyroid.

There is a marked improvement in symmetry since last visit. Skin is finer and noticeably whiter. Skin pretty good around nails; elbows almost smooth again; hands again taper. Breasts larger; more hair on genitals. Hair generally more oily again. Expression more intelligent; happier, gentler, sweeter. Doing better in school. Moves more quickly, both general motions and motions of eyes. A few pimples remain. Try three capsules a day.

May 14: General improvement in color, clearness of face and nails, whiteness and smoothness of skin, which feels warmer and very pleasant to touch. The changes in symmetry are particularly noticeable as before when taking capsules, in slope of shoulders, slenderness of waist, slenderness of hips, thighs and legs and ankles, and straightness of lower extremities. Less protrusion of abdomen and lordosis less marked. Hands seem lower down than formerly, which may be due to slope of shoulders. Neighbors who have followed case see marked improvement and one not familiar with case would see simply rather a heavy, stocky child, but not an abnormal one. Blood pressure, 100-70; pulse, 72. Weight, 103½ pounds. Height, 56 inches.

May 18: Has tolerance to 150 gm glucose.

May 19: Blood sugar (Dr. O. M. Schloss), 0.058 per cent.; just below normal, 3½ hr. p. c. Binet-Simon test for intelligence, 9 years, with recommendation for special training, with emphasis on teaching from concrete to abstract. (Miss Keller exclaimed on patient's wonderful complexion, its fairness and smoothness.)

Roentgenogram of sella, 15 mm. A. P.; 9 mm. D. (This photograph probably was a distorted view, as it was not taken with especial care to avoid distortion.)

Roentgenogram of wrist normal for age; pisiform showing.

May 22: Administration of two capsules at 12:30 p. m. Administration of 150 gm. glucose at 1 p. m. Injection of 0.5 c.c. Parke Davis "pituitrin" into subcutaneous tissue of right arm.

Blood pressure before taking capsules, systolic, 107; diastolic, 75; pulse, 72. After injection, systolic, 105; diastolic, 70; pulse, 72.

Urine first six hours, 1.036; faint trace of sugar; last eighteen hours, 1.030; no or very faintest trace.

Height and weight of other members of her family: Sister, aged 16 years, height 67 inches; weight 132 pounds; father, height 74 inches, weight 214 pounds; sister, aged 19 years, height 67 inches, weight 145 pounds.

DISCUSSION

DR. HERRMAN: What Dr. Haynes has said bears out the contention that very frequently more than one gland is affected. That observation was made many years ago, and there is no question that there is a correlation between certain ductless glands. I have been using a tablet containing extracts of the three glands, the thyroid, the suprarenal and the pituitary; and in some cases I have obtained better results than when thyroid treatment alone was used.

Regarding the relation between cretinism and the pituitary, I would mention that in a large number of cases that I have had under observation for years, I have never seen marked disturbances, giving the clinical picture of acromegaly.

As to the treatment of cretinism itself, I formerly employed only thyroid extract; but lately I have been using thyroprotein, with results as good but not better.

DR. GRIFFITH: I have had under observation during this past winter a child—if I may call him so—who has exhibited points of interest. The case demonstrates our lack of knowledge of the mutual relationship of the different internal secretions. He is a boy almost a giant for his age, but in other respects apparently a case of Froelich's syndrome. This would indicate both a hyperpituitarism and a hypopituitarism, which manifestly cannot exist at the same time. Clearly one must have followed the other, or there is something more than pituitary disease present. As far as the x-ray examination and sugar-tolerance are concerned the case appears to be one of Froelich's syndrome.

DR. HAYNES: I wish to say that the association of thyroid and pituitary has some experimental basis, in that the removal of thyroid has been noted to cause hyperplasia of the anterior lobe of the pituitary. Dr. Cushing has reported in the *American Journal of the Medical Sciences* cases similar to that of Dr. Griffith's, in which there was overgrowth with hypopituitarism.

THE ENERGY METABOLISM OF AN INFANT WITH CONGENITAL ABSENCE OF THE CEREBRAL HEMISPHERES *

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"The cerebral hemispheres, as we have more than once insisted, seem to stand apart from the rest of the brain."

"The salient fact about a frog lacking the cerebral hemispheres is that, as in the case of a frog deprived of its whole brain, the signs of the working of an intelligent volition are either wholly absent or extremely rare. The presence of the bulb or the middle parts of the brain ensure the healthy action of the vascular, respiratory and other nutritive systems; food placed in the mouth is readily and easily swallowed; the animal when stimulated executes various movements, but if it be left entirely to itself, and care be taken to shield it from adventitious stimuli, it either remains perfectly and permanently quiescent, or the apparently spontaneous movements which it carries out are so few and so limited as to raise the question whether they can fairly be called volitional."[1]

In warm-blooded animals the removal of the cerebral hemispheres is attended with much greater difficulties than in the case of the frog, while in the mammal it is most difficult. The writer, therefore, reports the results of the studies of a human infant supplied by nature's laboratory.

J. J. M. entered the Massachusetts General Hospital October 24, 1913. He was eight months old and was born February 10, 1913. His birth weight was unknown. Two months before entrance to the hospital the mother noticed that he was unable to sit up, hold his head up, or notice objects as do other babies of the same age. He was said to be a very quiet baby. He had always been breastfed and had gained weight rapidly, weighing 7,250 gm. on entrance to the hospital.

The physical examination showed a large baby with a thick layer of subcutaneous fat. The muscles were felt with difficulty and seemed to be relatively undeveloped. His head rolled about constantly when he was held up. He was

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* From the Nutrition Laboratory of the Carnegie Institution of Washington, and the Children's Medical Department, Massachusetts General Hospital.

1. Foster, Sir Michael: "Textbook of Physiology": London, 1898, 719.

TABLE 1.—Metabolic Activities of J. J. M.

Date	Body Weight, Kilos.	Body Surface (Meeh) Sq. M.	Height, Cm.	Age, Mos.	Actual Length of Period, Mins.	Carbon Dioxid per Hour, Gm.	Respiratory Quotient	Heat Produced per 24 Hours, Calories			Rectal Temperature		Average Pulse Rate	Relative Activity	Remarks
								Total	Per Kilogram	Per Sq. Meter	C	F			
Oct. 29, 1913	8.60	432	74	8	Preliminary 86	7.36	....	510	..	....	37.4	(99.4)	129	VI	Formula feeding about 2½ hours before the expt.
					Period I.. 23	3.84	0.86	266	31	616	37.0	(98.6)	...	IX	
Oct. 30, 1913	8.43	427	73½	8	Preliminary 29	5.18	....	404	..	....	37.9	(100.2)	107	V	
					Period 1.. 30	3.06	....	239	28	560*	....	....	75	II	Formula feeding about 7 hours before the expt.
					Period II.. 23	3.21	0.74	251	30	588*	....	....	71	III	
					Period III.. 30	5.94	....	464	55	1087	37.4	(99.4)	94	VI	
Dec. 10, 1913	7.45	393	....	9½	Preliminary 35½	5.30	....	409	..	....	37.0	(98.6)	115	V	Formula feeding about 1 hour before the expt.
					Period I.. 30	3.38	0.75	261	35	664*	....	....	96	III	
					Period II.. 30	3.36	....	259	35	659*	....	....	92	III	
					Period III.. 30	4.10	....	317	43	807	37.2	(99.0)	108	V	

Periods marked * were of least activity according to the kymograph records, though the baby was not absolutely quiet in any of the periods.

slightly pale. The anterior fontanel was slightly depressed and measured 2 by 3 cm. The posterior was closed. He was blind; the pupils were equal, of moderate size and did not react to light. Examination of the fundus by Dr. F. M. Spalding showed optic atrophy with considerable cupping of the disks. He had an idiotic expression. The knee-jerks were equal and lively; there was no Kernig sign, Babinski, or paralysis other than of the muscles of the neck, which apparently were paralyzed. The physical examination was otherwise normal. The Wassermann reaction was negative.

The baby, when left alone, remained absolutely quiet most of the time and did not seem to notice anything. Examination of the ear drums did not show anything remarkable; his actions in the ward gave the impression that he was deaf. Noises around him did not attract his attention. The slightest touch on any part of him always resulted in crying which at times resembled laryngismus stridulus. It seemed as though the reaction to touch was more rapid and more highly developed than in the normal infant. It was necessary to give him his supplementary feeding with a Breck feeder or dropper, but he took the breast well.

His metabolism was determined on October 29, 30 and on Dec. 10, 1913.

Operation for relief of blindness performed by Dr. W. J. Mixter on Nov. 1, 1913, showed that the hemispheres of the brain were entirely absent and replaced by cerebrospinal fluid. At the base of the skull there were a series of nubs, none larger than a small walnut, the posterior of which probably represented the cerebellum; the optic nerve was recognized. About 8 ounces of cerebrospinal fluid was removed and replaced with normal salt solution.

The Pulse Rate.—Each time it was taken in the ward the "baby jumped" and the pulse rate was recorded as between 120 and 140. The findings were different, however, when a stethoscope was attached with adhesive plaster over the heart in such a manner that the pulse could be counted without disturbing the infant. It was then found that the minimum pulse rate (viz., at rest) was 69 to 70 per minute, and the pulse rate during muscular exercise was between 120 and 140 per minute. The highest recorded pulse rate during activity was 176 per minute.

His weight, 8,400 gm., was 330 gm. heavier than the weight of average babies of the same age. After the operation he lost weight until November 19, when he weighed 7,500 grams, after which he gained up to 8,300 grams on November 30.

The metabolism was determined in the apparatus described by Benedict and Talbot[2] in "The Gaseous Metabolism of Infants."

The preceding table shows that the lowest metabolism was during Periods I and II on October 30, and the highest during Period III on the same date.

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2. Benedict and Talbot: Carnegie Institution of Washington. Publication, 201, 1914.

The following table shows the comparison between the metabolism of J. J. M. with a normal infant, R. L., of essentially the same age and the comparison of J. J. M. with another normal but very fat infant of approximately the same age but at a different period.

TABLE 2.—COMPARISON OF METABOLIC ACTIVITIES OF J. J. M. WITH NORMAL INFANT

Subject	Body Weight Without Clothing, Kg.	Height, Cm.	Age, Mos.	Periods	Heat Produced, Calories		Pulse Rate
					Per Kg. per 24°	Per Sq. Meter Body Surface (Meeh)	
J. J. M.	8.43	73½	8	2	29	574	73
R. L. (normal)*	7.58	71	8½	8	59	991	115
J. J. M.	7.45	.....	9½	2	35	661	94
E. G. (normal)*	9.37	74	10	5	51	907	106

* See Benedict and Talbot: Loc. cit., Note 2.

The comparison of one pathological infant with one normal infant is a distinctly untenable procedure, as has been frequently emphasized in connection with baby metabolism work. Since, however, the metabolism of baby J. J. M. is so extraordinarily different from the large group of normals which have been studied, it seems to be logical to make two selections from the group of normal infants previously reported and to use them here for comparison. Although these infants are not exactly the same age, weight and length as J. J. M., they are as close as can be found in literature and this comparison has a further advantage of being made on different babies examined in the same apparatus and by the same method.

It should be emphasized in this connection that E. G., while a normal infant, was fatter than the average baby and for that reason has a lower metabolism than the infant of the same age, but of average weight. The metabolism of J. J. M., as compared to R. L. on the one hand and E. G. on the other hand, is extremely low. Although periods of minimum muscular activity were sought for, the data shows that no periods had a relative activity less than two and that the values with J. J. M. were determined with some visible, recordable activity

as shown by the graphic records, while the values recorded for the normal infants used in this comparison had much less activity. This accentuates even more the extraordinarily low values for J. J. M., since the increased activity would obviously result in a somewhat higher heat production than he would have had if he had remained absolutely quiet.

The minimum metabolism in J. J. M. is relatively much lower than that of the newborn infants R. D. and N. H. and of the very fat infants E. F. and H. T.,[3] none of which produce less than forty-two calories per kilogram of body weight (556 calories per square meter of body surface) (Meeh).

Since this infant was deprived of the volitional areas of the brain, his life was similar to the frog in which the cerebral hemispheres had been removed. He, therefore, did not develop his musculature as would a normal infant of the same age, and, as a result, his body was made up principally of fat and bones with a small amount of muscle.

Were it not for the fact that the temperature remained constant during the time in which he was under observation, one might expect that there was some disturbance in the heat regulating apparatus. Furthermore, he cannot be compared to a hibernating animal, because his temperature remained normal.

The vital functions of this infant were, therefore, carried on at a very low plane because his existence was purely reflex. Unless some external stimulus caused him to move there was little or no muscular activity and as a result only a small amount of fuel was necessary to keep the furnace going.

DISCUSSION

DR. HOWLAND: Four years ago I reported the results on a child of some metabolism studies that were comparable to these. The child studied by Dr. Talbot was 8 months of age, while the one I studied was 8 years old, and weighed only 13 pounds. She was idiotic as the result of an old cerebrospinal meningitis, which had left her with contracted and ankylosed extremities. As she was almost without musculature, she could not make sufficient heat. Her weight was almost entirely in the parenchymatous organs and in her skeleton. In the case that Dr. Talbot has used in these metabolism studies, the weight was due almost entirely to fat. One would expect to have nearly comparable results in these two cases, so far as the heat production is concerned. There must be functionating tissue to produce heat.

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3. Benedict and Talbot: "Studies in the Respiratory Exchange of Infants," Am. Jour. Dis. Child., 1914, viii, 1.

DR. TILESTON: I should like to ask whether epileptiform convulsions were observed in this infant. In a case I saw, these were the main feature, with chronic spasticity of the limbs and attacks of tachypnea and tachycardia. I should like to hear a more detailed description of the clinical aspect of the case from Dr. Talbot.

DR. TALBOT: Unfortunately, the clinical history could not be obtained in any detail. So far as our knowledge of the baby goes, there were no changes in the respiration, and no nervous symptoms of any sort, other than what was noticed in the ward. That was a cry simulating laryngismus stridulus. Dr. Howland's case is a very interesting one. I have one other to report, in a child 3 years of age, who was a very lethargic cretin and had not been treated at all. His metabolism was almost as low as in the case I have reported today, and as is the case in the adult with myxedema or cretinism.

REPORT OF CASES OF VARIOUS TYPES OF IDIOSYNCRASY TO MILK

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[ABSTRACT]

Saunders and White in a paper on idiosyncrasies to milk, report a case of uncomplicated chickenpox, which presented all the appearances of malignancy for the first two days, due to an attack of acidosis, or as ordinarily termed, "cyclic vomiting," of which the child had had many previous attacks. According to their view cyclic vomiting, or "periodic auto-intoxication," with or without pernicious vomiting, as it might more properly be termed, is largely due to a milk idiosyncrasy, beginning often during the nursing period and showing a malignancy at this period greater than at any time subsequently. The tendency is toward destruction of the liver, and, in fact, one case is cited of acute yellow atrophy terminating an attack of pernicious vomiting in a child of 8 years, who had shown the syndrome of acidosis from the age of 4 months. The most fatal cases are those of infants at the breast, who show a family history of idiosyncrasy to milk either total or partial.

Parke, several years ago, and Abt recently, have well described this class of cases, although they have not connected them etiologically with milk idiosyncrasy. Weaning, prophylactically if the family history be bad, exclusion of milk from the diet, alkalies and stomach washing will save these infants. There is generally gastric catarrh present. There is another large class of cases characterized by varying symptoms, but of all of whom it may be said that they either fail to gain or do not sleep quietly, and in whom no modification of milk diet succeeds. In the dietetic treatment of this class it should be the invariable rule to abolish all milk and to seek to bring the child to a thriving and comfortable condition, after which milk may be cautiously tried again. The old dictum that the pediatrician should always succeed in obtaining a milk mixture suitable for any child, is simply not true. A third class of cases is found among children and young adults. Briefly

speaking, vertigo, mental and physical inertia, and frequent attacks of what are commonly termed biliousness, characterize this class. In some of them a moderate amount of milk may be tolerated; in others not a single grain, not even as much as is found in ordinary baker's bread. Anorexia and anemia, sometimes coming on with surprising suddenness, are symptoms also pointing to milk idiosyncrasy.

ALLERGY TO COMMON FOODS. A PRELIMINARY REPORT

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NEW YORK

The object of this communication is to report briefly certain observations derived from a study of forty-three cases of food idiosyncrasy. The cases observed were ones of idiosyncrasy to milk, egg, beef, horse protein, wheat, rice and other cereals and various nuts. It was unusual to find that the idiosyncrasy was confined to a single food substance, but as a rule it was manifested toward several of those enumerated.

Among the most frequent symptoms due to food intolerance are urticaria and angioneurotic edema. These disturbances may be local or general. In some of the severer cases the ingestion of a toxic food is followed immediately by urticaria and angioneurotic edema of the lips and the buccal and pharyngeal mucous membrane with which it comes in contact. The general form may involve the skin of the entire body and appears within one half to three hours after the food is ingested. In two cases I have seen exudative erythema and urticaria appear one half to two hours after the ingestion of egg or oats.

The relationship of eczema to food allergy is of great interest. In nearly every case of food idiosyncrasy which I have seen, and in a large proportion of the reported cases, eczema had existed at some time. During the past two and a half years I have observed eighteen cases of pronounced eczema and in sixteen cases a cutaneous reaction was caused by the proteins of one or several foods. In fourteen patients a reaction was caused by egg protein and twelve patients showed a reaction to cow's milk. Several reacted to the cereals and a few to a large number of foods. Three infants showed a reaction to the proteins of breast milk. That the relationship of the food idiosyncrasy to the eczema may be causative, is attested by the therapeutic results to be mentioned later. In many instances, however, the withdrawal of the toxic food or foods was not followed by a prompt disappearance of the eczema. As mentioned previously,

the allergy, judging by the cutaneous reaction, is nearly always manifested toward several foods, and it is quite possible that the eczema may have been due to some unsuspected food substance.

A third group of toxic disturbances consists of asthma or asthmatic bronchitis. Cases of asthma due to the ingestion of egg are not uncommon and such have been reported by Talbot and others. Similarly, asthma may be due to the ingestion of other foods, but the relationship is far from constant. I have seen several cases in which attacks of asthma could be provoked by the ingestion of certain foods and prevented by elimination of such. A number of cases, however, were investigated with only negative results. Two patients gave a cutaneous reaction to many foods, but dietetic experiments were of no definite value.

A fourth group of symptoms are gastro-enteric in origin — vomiting, pain and diarrhea—and are due probably to a direct irritant action exerted by the foods.

In a fifth group is the blood reaction which consists of eosinophilia. It has been observed by Schlecht and his co-workers, Schittenhelm and others, that a pronounced rise of the eosinophil cells in the blood follows anaphylactic shock. In a number of cases of food idiosyncrasy a marked increase of the eosinophil cells occurred at the time of or directly following toxic food disturbances.

The next question for consideration is the cutaneous reaction. A great number of the subjects of food allergy give a cutaneous reaction to the toxic foods. In the more pronounced cases, simple massage of the food or protein into the skin causes the appearance of crops of urticarial wheals. Inoculation of the food or protein into a skin abrasion causes the appearance of an urticarial wheal surrounded by a zone of erythema. So far as has been determined, the reaction occurs only in cases of food allergy, except in the presence of marked factitious urticaria. This source of error is eliminated by a control test. Often the test is elicited when an aqueous extract or paste of the food is applied to a skin abrasion, but in other cases the reaction is present only when the proteins are used in a comparatively pure state.

An observation of interest is the fact that the cutaneous reaction and also the toxic disturbances may disappear for some time after food poisoning. In four cases of allergy to egg the reaction disappeared for several weeks after illness due to ingestion of egg.

In reference to the significance of the cutaneous reaction, it is only fair to state that in some instances equivocal reactions occur so that the dividing line between negative and positive becomes very fine. Such instances, however, are few and further study may eliminate this difficulty.

The nature of the idiosyncrasy is the next consideration. In all cases in which I have been permitted to make complete tests, the offending food constituents have been the proteins. It is unnecessary to consider such tests in detail, as this has been discussed fully in a previous communication based on the study of a patient with an idiosyncrasy to egg, almonds and oats. In a case of idiosyncrasy to egg and beef protein, in a case of idiosyncrasy to milk and one to oatmeal, such experiments showed that the proteins alone were concerned.

In two cases of idiosyncrasy to egg, one case of idiosyncrasy to milk and one to oats, it was possible passively to sensitize guinea-pigs by injections of the patient's blood or serum. These experiments indicate that the idiosyncrasy is due to protein sensitization or anaphylaxis.

The experiments in relation to milk are of special interest, as there has been a general discussion, especially in the French and German literature, concerning the nature of these cases. The patient whom I observed reacted to milk by the development of severe urticaria, angioneurotic edema and gastro-enteric disturbances. In another patient who reacted by the development of gastro-enteric disturbances only, passive sensitization experiments were negative and it is with this type of case that all of the reported negative results were concerned.

Numerous experiments on anaphylactic shock have shown that when the animal recovers from the intoxicating dose of protein it then becomes immune to further injections. This immunity, however, is only temporary, and within one to three months the animal again becomes sensitive. It is of interest to know to what degree this phenomenon of antianaphylaxis takes place in human beings. I have mentioned previously that after food poisoning the cutaneous reaction may disappear. Important evidence, also, is the fact that patients once immunized to egg do not remain immune unless egg in comparatively large amounts is ingested continuously.

In two patients it was possible to carry out definite observations on the occurrence of antianaphylaxis. Both patients reacted to the ingestion of egg by the development of general urticaria which appeared within one to three hours. Following each attack the cutaneous reaction disappeared from twenty-two to forty days and during this period the ingestion of egg was without results. With the reappearance of the reaction, egg again caused the usual symptoms. This observation was made a number of times on both patients. These results serve to explain how anaphylactic disturbances may be intermittent or cyclic even though the food responsible was ingested continuously. They also indicate the necessity of making repeated tests in suspected cases.

The origin of the food idiosyncrasy is of great interest and is often difficult to explain. In many instances the family history indicates that the condition is inherited. Often it is possible to obtain a history of similar idiosyncrasy in the parents and grandparents, and in some instances several children were affected.

In other cases the allergy is acquired, as the patients had previously ingested the same foods with no discomfort. It has been shown that feeding foreign proteins to animals may cause sensitization, and it seems possible that this may be a factor in the cases of food idiosyncrasy in human beings.

The diagnosis of food allergy is made either clinically by the appearance of toxic symptoms following the ingestion of certain foods, or by means of the cutaneous reaction.

The treatment must vary according to the type of the idiosyncrasy. The ideal method is that of desensitization by the administration of gradually increasing amounts of the toxic protein. A second method is by elimination of the offending article from the diet. The results of treatment have been most satisfactory in cases of egg or milk idiosyncrasy. It is quite possible to induce desensitization by feeding gradually increasing amounts of the offending protein.

In three cases of bronchial asthma and egg idiosyncrasy there was great improvement in the asthma after desensitization. Other cases of asthma gave a cutaneous reaction to a number of foods but either complete investigation was impossible or the treatment was without result. In a number of cases no cutaneous reaction could be elicited.

The treatment of eczema of allergic origin is a problem of great difficulty and must vary with the individual patient. Unfortunately, a number of these patients react to several almost essential foods — usually to egg, and often to milk and the cereals. In three cases of eczema in older children the eczema disappeared promptly following elimination of the foods to which they reacted.

In a young infant the difficulty of eliminating milk from the diet is great and for this to be possible we must have satisfactory substitute foods. In five cases of eczema in young infants the rash disappeared after the foods to which they reacted were eliminated. In two of these cases, however, there were mild recurrences.

One infant gave a reaction to cow's milk, wheat, oats and barley protein. He was given a food made from soy bean flour, washed butter, potato flour and milk sugar. The eczema disappeared in five days. Milk was added in gradually increasing amounts, the eczema disappeared and the cutaneous reaction to milk was lost.

In another case a mixture of beef fat and olive oil, beef protein, dextromaltose and rice flour was used with identical result.

In two other cases the use of similar mixtures produced an improvement in the skin condition, but caused a gastro-enteric disturbance, so that the food was discontinued.

In other cases of eczema the cutaneous reactions were not sufficiently marked to serve as a dietetic guide.

In conclusion, I wish to state that a number of cases of eczema and a few of bronchial asthma will prove to be due to food allergy. In some of these cases at least, a rational treatment may be arrived at on this basis. At present my own experience does not warrant the belief that a satisfactory result can be attained in all cases in which it is reasonable to suppose that the disease is of food origin. It seems possible, however, that this is due to the lack of satisfactory substitute foods and to difficulties in obtaining a distinct cutaneous reaction in all cases. Further experiment may aid in the removal of these obstacles.

DISCUSSION

ON PAPERS OF DRS. SAUNDERS AND WHITE, AND DR. SCHLOSS

DR. HOWLAND: The reaction that patients with eczema show to the various proteins has lately excited much attention. Within the last few months Dr. Blackfan has made cutaneous and intracutaneous tests on twenty-three patients with this condition. All are sensitive to one or more proteins—almost all, to egg; most of them to cows' milk; one or two to breast milk; and two or three to horse serum. These children have not shown any gastro-intestinal symptoms. Almost

all are sensitive to more than a single food substance. Dr. Blackfan's experience has been almost exactly like that of Dr. Schloss. The intracutaneous test was more sensitive than the cutaneous, but more difficult to interpret. It is often impossible to say whether it is positive or negative. So far as he has been able to make out, the condition differs somewhat from true anaphylaxis. It has been impossible to produce passive sensitization in animals, and it has been impossible to obtain precipitins from the blood. The children are sensitive to so many proteins that it is hard to give them a food on which they can be nourished. All, when put on diminished food, responded rapidly; but within four or five days to a week afterward the infants showed a return of their symptoms. One or two of the older children, with marked symptoms, were entirely cured as soon as the offending protein was removed. One child who was sensitive to cow's casein was fed on a mixture of cereal, washed butter, scraped meat and dextrimaltose. He gained and in the first four or five days improved so much that the eczema was absent; but within a week it returned, and is now as bad as before. Therapeutically, there is a small number of cases that can be cured or very much improved; but there is a large number that at present cannot be improved.

DR. TALBOT: I have followed Dr. Schloss' work with a great deal of interest, ever since I heard his first paper three years ago. Following his suggestions, I have tried his method in cases of asthma, with the same result that he has reported. The longest absolute cure that I have had is three years. I have six or seven children who have lost their skin test to the offending protein and are presumably cured, within periods extending from three months to the three-year case. I have been fortunate in seeing a large number of cases of asthma recently, and in about 60 per cent. of them I have found a positive skin test to some food. In the majority of the others I have not found any cause for the asthma—probably because I have not tried enough of the possible proteins. In the ones with positive skin tests, egg is the most common offending article. With egg, in the majority of my cases, there has been a positive reaction to nuts; and the English walnut has been the most common of these nuts to produce the reaction. In several instances I tested six different kinds of nuts, and my experience so far has been that the peanut is the only one that did not react when the other nuts did; the peanut, however, is of the bean family and is not a true nut. Many of these cases that are sensitive to eggs are also sensitive to horse serum. I have recently seen a case that was sensitive to horse serum, to an alcoholic extract of the scrapings and the hairs of two horses, and to five different kinds of nuts, to beef juice and to milk, but negative to egg. I had the same experience that Dr. Schloss had in a case with a positive reaction to hen's eggs, and also to pheasant, guinea fowl, pigeon, turkey and duck eggs. In the majority of my cases, there has been a definite history of inheritance, either on the father's or the mother's side, or on both.

In all but two out of thirty odd cases of asthma that I have been able to study carefully, the patients also had eczema. The results are very striking when one is able to immunize a child to the offending protein. Unfortunately, there are certain cases that seem to be so sensitive that it is impossible to work up the tolerance of the child to that protein. For instance, one child that I have been treating now for fourteen months I have worked up to 10 milligrams of egg a day; but I have been unable to work him up any higher, because each time he goes higher it brings on an attack of asthma, which puts him back a week or ten days. In most of the other instances, after the amount of egg that

has been given has reached as high as about 50 to 75 milligrams a day, there is a definite improvement in the appearance of the child and a diminution in the duration and the severity of the attacks, and the children change their lives and habits from those of an invalid to those of a normal child. I think that Dr. Schloss deserves great credit for his work, because it is the first step in the explanation of many conditions that we were unable to do anything for before he started his investigations.

DR. MORSE: I should like to ask Dr. Schloss and Dr. Talbot whether they think that all cases of asthma and eczema are due to food allergy?

DR. TILESTON: I think that the researches of Dr. Schloss promise to throw a flood of light over conditions that have resisted treatment, particularly skin diseases. There are a number of skin conditions that have not been thoroughly understood, and some are going to be shown to be due to anaphylaxis. The common condition of aphthous stomatitis is due, in some patients, to eating walnuts; and it is probable that most cases may be due to some form of protein sensitization. In that interesting condition described by Osler as the visceral complications of erythema multiforme, it seems probable that a cure might be brought about by this method; whereas, formerly it was practically incurable, and led, in not an inconsiderable proportion of cases, to a fatal outcome. These patients often have severe colic in the right iliac region, and are suspected of having appendicitis. I have had two cases recently that were recommended for operation; but they showed, at the same time, urticaria on the skin, and no operation was performed. They have never since shown any sign of appendicitis.

DR. HOOBLER: I should like to ask Dr. Schloss in what proportion of infants he finds this reaction?

DR. HAMILL: In attacking this problem from an entirely different standpoint from that of Dr. Schloss, I have given the test, using various proteins, routinely. The object that I had was this: I first started out with cases having definite manifestations of anaphylactic phenomena, but, feeling that it was possible that manifestations might exist that were not generally recognized, I applied these tests routinely, and attempted to work backward and try to discover previous evidence of anaphylaxis in the cases that reacted positively.

I have not yet proceeded far enough in the work to reach definite conclusions, but I have been impressed with the number of cases in which I have obtained positive reactions in children, who had been in ill health for long periods of time, with no very definite manifestations of anaphylaxis, chiefly in the gastro-intestinal tract, such as recurrent attacks of diarrhea or vomiting. The number of proteins to which some of these children reacted was very striking. I have used in children, depending on their ages, the proteins of egg albumin, cows' milk, beef, mutton and fish. I have in my ward at the present time a case of asthma that has reacted to all these proteins. Reaction to egg albumin was the most striking, and its withdrawal had a definite effect on the frequency of the test. The child had had attacks every day for the past twenty months. The egg albumin was then withdrawn and the attacks ceased entirely for ten days, but then recurred. I then applied the other tests. Finding the reaction to cows' casein was then the most striking, I withdrew the milk and the child improved.

It has always seemed to me that any toxic substance must manifest itself in individuals in a mild degree, and in a degree that we do not recognize because we do not find the phenomena by which these cases are ordinarily recognized. It was with the thought of the value of seeing whether, working backward to

the history of the case, one might find evidence throwing light on some of the indefinite conditions of ill health in childhood that we frequently recognize, and for which we are able to do little, that these studies were undertaken.

DR. HAYNES: I have had the opportunity to treat several cases of asthma and eczema in which the child was sensitive to egg, and in which it was necessary to limit considerably the amount of chicken that the child took, as well as the egg. I have noticed that the rules of diet prescribed would sometimes be transgressed, the child getting a little egg or a little meat; and that while in such cases it might not actually develop asthma, it would do one of two other things: Either the eczema would return, or the child would develop a persistent cough at night on going to bed, which was relieved by a renewed rigid application of diet. The eczema would return with a slighter indiscretion in diet than was necessary to bring on asthma.

DR. HEIMAN: My experience is somewhat similar to that of Dr. Haynes. I intended to ask whether this occurred with all eggs, or whether Dr. Schloss has discriminated between certain types of eggs; whether it is a constant food allergy caused by the egg protein? I should also like the doctor to tell us how he applied these cutaneous tests. In a case of milk allergy, I tried the cutaneous reaction, and found that it answered very well indeed; but I should like to know how he applies the reaction noted with other substances.

DR. FREEMAN: I think that many children have been injured by the assumption that because they have at one time seemed to have an idiosyncrasy against cows' milk, they always have such an idiosyncrasy. Milk is never given to many children, because in babyhood they had been supposed to have been upset by it. I have never known any child to whom I could not give milk if, following the teaching of Dr. Schloss, I began with a small enough amount and gradually increased this to a normal amount. These children usually do better when milk is given.

DR. PORTER: I should like to ask Dr. Schloss to tell the means by which the children become sensitized originally.

DR. COWIE: I want to compliment Dr. Schloss on his splendid piece of work. One of the most important points brought out by Dr. Schloss may explain the failure I have had in carrying out this test in some of my asthma cases. I have made only one, or at the most two, skin tests in each case, while Dr. Schloss made successive tests, in some cases extending over a period of thirty-five days. The importance of the differential count seems to be well shown. In some cases in which no or only slight skin reaction occurred, the eosinophil increase appeared. The interpretation of the results obtained in the skin and in the blood by successive skin tests should be carefully considered.

DR. GRIFFITH: It seems likely that other articles of diet than protein may produce the symptoms described. I have seen in some cases a mere change of the variety of sugar in the milk mixture promptly followed by the cessation of an obstinate eczema.

DR. ABT: While these foods are taken care of badly and receive a toxic response from the organism in some children, a large number of other children will take them without this reaction. It has occurred to me, therefore, to ask whether the abnormality is in the food or on the part of the child. If the latter, have we any means of classifying the idiosyncrasies on the part of the children? Shall we subject the hypothesis of Czerny and the German school concerning the exudative diathesis and other constitutional defects, or shall we say that the foods cause the reactions and that peculiarities of the organism do not occur?

DR. SCHLOSS (closing): Dr. Howland stated that he had been unable passively to sensitize animals with blood from patients affected with eczema. I, also, have made such investigations in reference to both eczema and asthma but with negative results. It has been only in cases of marked allergy to egg or milk in which the patient's symptoms were comparable to anaphylactic shock in animals that the results were positive. In such instances it was possible passively to sensitize guinea-pigs to the proteins of these foods by preliminary injection of the patient's blood or blood serum.

In reference to the treatment of eczema, I did not wish to give the impression that all cases can be permanently cured on the basis of the treatment outlined. In several cases the eczema recurred even though the patient continued with the diet. In one instance this was due to sensitiveness to an unsuspected protein (oats). In other instances the cause was not apparent, judging from the cutaneous reaction.

I do not feel in a position to answer definitely the question of Dr. Morse. It has always been thought that eczema in infants was due most often to the disturbing influence of sugar or fat. In the greater number of cases which I have investigated the evidence pointed to the protein as the offending element. One cannot feel sure, however, that fat or sugar may not act as a contributing cause or even in some cases as the exciting cause. A definite solution of this problem must await the results of further investigation.

The asthma of infants and young children is probably of multiple etiology, and judging from my experience the percentage of cases in which allergy to food can be established as the cause, is small. It seems possible, however, that perfection of the methods of diagnosis will show a larger percentage.

With reference to Dr. Hoobler's question, I would say that I have made over eighty control inoculations, all of which were negative. Dr. Talbot has made one hundred routine tests with egg and in only one case was a positive result obtained. This was in a case of eczema.

In regard to the type of case referred to by Dr. Hamill, I cannot add anything because I have no experience with this type of disturbance.

Patients allergic to hen's eggs will react also to duck, goose and turkey eggs and to the blood serum of these animals.

The test is more definite when the pure proteins are used. The method of preparation varies with the protein.

The technic of the cutaneous test is identical with the von Pirquet tuberculin test. The intracutaneous test is applied by injecting a minute quantity of the protein into the skin.

Dr. Porter's question as to the manner in which the patients become sensitized is difficult to answer definitely. In many instances the condition is probably inherited, as indicated by the family history. In other cases the patients are probably sensitized by the passage of unaltered protein through the intestinal wall.

As stated by Dr. Griffith, urticaria may be due to substances other than protein and I did not wish to intimate even that urticaria was always a symptom of protein idiosyncrasy. That urticaria is a very common symptom of food allergy is too well established to question.

THE PROTEIN NEED OF INFANTS

BEING METABOLISM STUDIES OF A TWO MONTHS' OLD INFANT FED WITH VARYING PROPORTIONS OF COW'S MILK PROTEIN *

B. RAYMOND HOOBLER, A.M., M.D.
DETROIT

The problem of determining the optimum quantity of protein necessary for the growing organism has been the subject of numerous observations. The result of feeding to an infant large quantities of protein over a prolonged period has not been studied to the extent it deserves and it was with a desire of increasing our knowledge on this subject that the work detailed in this paper was carried out.

It has been shown many times that the growing organism requires a certain quantity of protein for the replacement of tissues due to "wear and tear" as well as for growth of body, true growth being intimately associated with the retention and fixing of nitrogen compounds as integral parts of the body. No doubt the amount of protein required varies from time to time in accordance with what Mendel[1] has been pleased to call the "growth impulse." However variable may be the demands of this "growth impulse" for protein, it can never be as variable as the supply which is furnished, particularly in artificially fed children. When the baby is breast fed the protein intake is more constant, although it naturally will vary with the protein content of the milk, being highest in the first few days of lactation, quickly diminishing as colostrum changes to milk, and then remaining fairly constant to the end of lactation. Barring these variations the breast fed infant is subjected to much less disturbance in protein supply than the average artificially fed child.

The proportion of protein supplied in mother's milk should be a helpful criterion in determining the protein requirement. In his

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1. Mendel: Trans. Fifteenth Internat. Cong. on Hyg. and Demog., Washington, 1913. ii, 429.

Harvey Society Lecture Howland[2] has stated this point clearly. He says:

> There is every reason to believe that the amount [of protein] furnished a healthy nursing infant represents at least a sufficient quantity and cannot be much in excess. However, since only 80 per cent. of the nitrogen of human milk is available (the other 20 per cent. being in the form of urea and extractives) one may, when feeding cow's milk, where practically all the nitrogen is available, reduce the quantity of protein to an amount equal to 80 per cent. of that supplied by mother's milk. Since about 8 per cent. of the total energy of mothers milk is supplied by protein, and since 20 per cent. of this energy is in a form which cannot be used, one may from this line of argument decide that 6.4 per cent. of the total energy of a food should be in the form of utilizable protein.

This argument is quite contrary to modern practice. Rubner[3] however brought out this point clearly some time before when he suggested that the diet of the growing infant should be relatively poor in protein. He based his finding on the results obtained in studying the nitrogen metabolism, which showed that a child kept up normal growth when 7 per cent. of its total energy intake was in protein; that 5 per cent. was sufficient for maintenance; that even 4 per cent. was sufficient to supply its actual need when amply supplied with carbohydrate.

Rubner's original discussion is appended in footnote 3.

Whether a child be fed naturally or artificially, therefore, it is evident that protein up to a maximum of 7 per cent. of its caloric need will meet all its requirements.

In the course of its existence the child increases in musculature and activity; its "wear and tear" quota increases and the "growth impulse" impels the organism to increase its bulk of protoplasm, and thus there is generated an active demand for protein. Should this demand be not supplied, then, according to Rubner[4] the "growth impulse" becomes latent, there is no growth, even "wear and tear" is not taken care of. Again, should this demand be just supplied, then growth takes place and tissue is renewed. But what results when

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2. Howland: Harvey Society Lecture, March 29, 1913.

3. Rubner: Im Hinblick auf diese Verhältnisse ist es schon in hohem Masse interressant, dass in der Wachstumkost die von Heubner und mir beobachteten Saüglinge überhaupt nur 7 per cent. in Kalorien in Eiweiss geboten waren, und dass bei Erhaltungskost sogar nur 5 per cent. des Kalorienumsatzes auf Eiweiss treffen, ja wenn man die Resorptionsverhaltnisse noch mit heran zieht, so reichte der Säugling vollkommen für seine Bedürfnisse mit einem Umsatz, von dem nur 4 per cent. auf das Eiweiss treffen, Arch. f. Hyg., 1908, lxvi, 97.

4. Rubner: Arch. f. Hyg., 1908, lxvi, 109.

protein is supplied in excess? Can it stimulate growth? In reply to this Rubner[5] ten years ago said: "Growth is not proportional to the quantity of the protein in the diet." "Protein cannot raise the rapidity of growth above the limits set by nature."

What, then, becomes of the additional protein fed, over and above the need for maintenance and growth? To quote Rubner[5] again, "As the amount of the protein in the diet increases, a smaller percentage is utilized [for growth] and the excess of the intake is merely consumed in place of an equivalent of non-nitrogenous food."

The question then naturally arises, can any harm come to a growing organism through the feeding of an excess of protein?

To answer with any degree of thoroughness one must inquire as to the various changes which protein undergoes in its transition from an external food product to the cell of the living organism.

Before being absorbed into the body all protein must be first split into amino-acids, as has been so clearly demonstrated by Abderhalden.[6] These amino-acids when once within the body combine and are builded into the tissues, forming new cells or repairing old ones. But what becomes of those amino-acids absorbed in excess of the need for repair and growth?

Rubner,[7] discussing this point, believes that the excess is eventually oxidized in the same manner as carbohydrate and fat. His original language is appended in footnote 7.

There is a further question, viz., Just what is the effect on the growing organism of the combustion due to the metabolism of the protein? A number of observations have been made which show in part the results which follow an increased ingestion of protein for short periods.

Howland[8] working in Prof. Lusk's laboratory was able to demonstrate an increase in the heat production of 10 per cent. by addition

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5. Rubner: Arch. f. Hyg., 1908, lxvi, 110.

6. Abderhalden, E.: Synthese der Zellbausteine in Pflanze und Tier, Berlin, 1912, p. 101.

7. Rubner: Das Eiweiss, welches über den bedarf des ersatzes (E) unter das wachsthum (W) hinaus aufgenonommen wird, vertritt dann die sonst verbrauchten Nahrungstoffe, Fett order Kohlehydrate, ist also im gewissen Sinne eine überflüssige Zufuhr und zudem unter Umständen durch die dynamischen Wirkungen ein an sich entbehrlicher Energieverbrauch, Ztschr. f. exper. u. Therap., 1905, i, 1.

8. Howland: Ztschr. f. physiol. Chem., 1911, lxxiv, 1.

of 15 gm. (5 gm. to each of three feedings) of nutrose, a dried casein product containing 89.06 per cent. protein, to the food of a child 3 months of age, and an increase of 26 per cent., by addition of 30 gm. nutrose per day to the diet of another child 7 months of age.

Table 1, based on Howland's[9] work, shows the effect of excess protein on the carbon dioxid as well as the heat output in Child 1 (3 months old) and Child 2 (7 months old).

TABLE 1.—EFFECT OF EXCESS PROTEIN ON CARBON DIOXID AND HEAT OUTPUT IN INFANTS

	Length of Time Studied	Food	CO_2 Per Sq. Meter Per Hr.	Calories Per Square Meter Per Day	Increase Per Cent.
Child 1....	Average of eleven sleeping hours	One-half milk and sugar	17.01	1,094	..
Child 1....	Average of four sleeping hours	Same and 15 gm. nutrose	18.21	1,210	10
Child 2....	Average of seven sleeping hours	Three-fifths milk and 5 per cent. sugar, and 30 gm. malt extract	19.21	1,270	..
Child 2....	Average of five sleeping hours	Same plus 30 gm. nutrose	23.64	1,595	26

TABLE 2.—INCREASED METABOLISM IN AN INFANT FROM INCREASED PROTEIN

	Length of Time Studied	Food	Calories Per Hour	Calories Per Sq. Meter Per 24 Hours	Increase Per Cent.
Child C. P., aged 2 months	Average of four sleeping periods	Dil. cow's milk, 11 per cent. protein cal.	7.32	907.5	....
Child C. P., aged 2 months	Average of two sleeping periods	Eiweissmilk, 29.6 per cent. protein cal.	8.12	1,021	12.5

Murlin and I[10] showed an increase of 12.5 per cent. in the metabolism of a 2 months'-old baby when the proportion of the calories in the food arising from protein was raised from 11 per cent. to 29.6 per cent. Details of the experiment when tabulated are as shown in Table 2.

9. Howland: Trans. Fifteenth Internat. Cong. on Hyg. and Demog., Washington, 1913, ii, 430.

10. Murlin and Hoobler: AM. JOUR. DIS. CHILD., 1915, ix, 81.

Before discussing the results of the work covered by this paper I wish to express my thanks to Prof. Lusk, of the Physiological Department of Cornell University Medical College, and Dr. L. E. LaFétra, Chief of the Children's Service in Bellevue Hospital, for many helpful suggestions and constant encouragement. Thanks are also due to the corps of efficient assistants who very kindly cooperated in the technical operation of the calorimeter. According to a plan outlined by Prof. Lusk it was decided to begin with a low protein diet and determine metabolism on such a diet for this child and then gradually to increase the protein content relatively and actually, maintaining the fat and carbohydrate content as nearly as possible on a level throughout the observations.

The child was under observation sixteen days in all, being in the calorimeter two or more hours daily from March 24 to April 10, inclusive, except the two intervening Sundays, March 28 and April 4, during which time thirty-seven periods of one hour each were studied, the first six periods being studied in the respiration chamber devised by Dr. Murlin,[11] in which the metabolism was determined by indirect method and the balance in the small calorimeter of the Atwater-Rosa type in which the metabolism was determined both directly and indirectly. The work of the Murlin apparatus demonstrated its efficiency, since the findings under same conditions of food, repose, time after feeding, etc., were practically identical with those obtained with the Atwater-Rosa calorimeter.

Throughout these entire sixteen days the child was kept on the metabolism frame devised and described by me[12] and seemed in every way as comfortable as in the hospital crib. Without a single exception the urine was completely and accurately collected and daily analysis was made of its nitrogen content.

The caloric value of all food given was determined by bomb calorimetry, and the nitrogen content of each day's feedings was carefully determined by the Kjeldahl method, so that there was a perfect record of the caloric as well as of the protein intake. Incidentally this revealed some startling discrepancies between the supposed and the real value of milk formulas as usually made up, and indicated the very great necessity of actually determining the caloric value of food by bomb calorimetry in all metabolism studies in which the caloric intake is

11. Murlin: AM. JOUR. DIS. CHILD., 1915, ix, 43.
12. Hoobler: AM. JOUR. DIS. CHILD., 1912, iii, 253.

considered. The bomb calorimeter used was that devised by Mr. Riche, under whose guidance the work was done.

The infant chosen for this series of observations was a robust, healthy boy aged 2 months, who had been deserted by his mother after having been brought to the hospital. He had been under observation in the hospital for some time and was gaining in weight, taking his feedings well and the stools were perfectly normal.

The first four days the child was fed on one-third whole milk with 5 per cent. dextrimaltose added, during which time the metabolism on low protein diet was determined. The child was then placed for one day on slightly increased protein diet, and the following day was put back again on low protein diet; this continued each alternate day,

TABLE 3.—ENERGY METABOLISM WHEN FED ON COW'S-

Date, 1914	Period No.*	Weight in Gm.	Surface Area per Sq. Meter y=mx+b (Howland)	Kind of Food	Distribution of Cal. in Food	Cal. per Kilo.	Cal. in Last Feeding	Cal. in 24 Hrs
3/24	1	4,364	0.2830	Diluted cow's milk with sugar added	P.11%-F.25%-CH.64%	80	39	351
3/25	1	4,371	0.2840	Diluted cow's milk with sugar added	P.12%-F.27%-CH.61%	74	36	324
3/26	1	4,350	0.2830	Diluted cow's milk with sugar added	P.12%-F.27%-CH.61%	74	36	324
3/27	2	4,350	0.2830	Diluted cow's milk with sugar added	P.14%-F.27%-CH.60%	74	36	320
4/ 1	1	4,406	0.2858	Diluted cow's milk with sugar added	P.12%-F.27%-CH.61%	77	42	338
Av. of 5 sleeping periods		.....	.....	.....	P.12.2%-F.26.4%-CH.61.4%	76	38	331.

* Sleeping periods only used.

gradually increasing the protein intake, until the last five days, when the child was placed on maximum quantities of protein in the form of albumin milk prepared by the Walker-Gordon Laboratory. The protein on certain of these days was increased by the addition of nutrose, and on the last day double strength albumin milk was fed.

The clinical condition of the child continued normal up to the last two days of the series, when it was noticed that the child no longer took an interest in his surroundings, and gradually entered into a state of semistupor. The pulse was slower and there were times when the respirations were slightly irregular. The stupor continued for a few days after the observations ceased. The child on being taken off the metabolism bed was put back on the same diet on which he was before

the studies began. The stupor gradually lessened, so that within one week the child was normal again and began to gain in weight.

During the first eleven days the weight gradually increased, but there was a rapid loss during the last five days. The quantity of urine diminished greatly but no acetone bodies were present and the stools became yellow and watery. The temperature was taken both in the calorimeter and in the ward and at no time was it found to be above normal, but on the contrary was slightly below normal at times.

The deleterious results of feeding large amounts of protein has already been hinted at under the term *"Eiweissnährschaden"* by Salge,[13] but he was unable to give the specific clinical symptoms accompanying such injury, and so far as I am aware the clinical symptoms

ILK (DILUTED) AND SUGAR, BEING A LOW PROTEIN DIET

Time nce Last Feeding	Respiratory Period	CO_2 per Hr., Gm.	CO_2 per Sq. Meter per Hr., Gm.	O_2 per Hr., Gm.	R. Q.	N in Urine in 24 Hrs., Gm.	N in Feces in 24 Hrs., Gm.	Cal. Produced per Hr., (Calculated)	Cal. Produced per 24 Hrs.	Cal. per Sq. Meter per 24 Hrs. (Howland's Formula)
. 45 min.	10:45-11:45	3.91	13.8	3.07	0.92	0.924	.3450	10.56	259.5	895
. 38 min.	10:38-11:38	3.96	13.9	3.19	0.92	1.008	.4090	10.74	256.7	907
s. 10 min.	11:10-12:10	4.00	14.1	3.20	0.93	1.008	.4090	10.75	259.2	912
. 54 min.	11:54-12:54	4.13	15.5	3.25	0.92	1.008	.5953	11.31	256.8	907
in.	10:36-11:36	4.07	14.2	3.00	0.99	1.169	.2819	10.54	241.6	845
.....	.....	4.01	14.1	....	....	.....	.....	10.78	254.8	893

above described have never before been charged to an excess of protein in the diet. The condition was not one of so-called acidosis, for it was not accompanied by the dyspnea typical of that state, neither was the carbondioxid output lowered. The urine did not contain the acetone bodies. The appearance also differed from acidosis in that the child lay in a motionless position with eyes wide open and staring. The features were not drawn. There was no difficulty in breathing, but rather there was a slowing of respiration. As soon as the protein was diminished the symptoms gradually disappeared and child became normal. It seems to me that symptoms similar to the above but less

13. Salge: Kinderheilkunde, Berlin, 1912, p. 112.

pronounced may be observed in various stages of malnutrition when children are fed on sugar and fat-poor diet.

Passing now to a study of the tables presenting the work done, we note that Table 3 gives in detail the various data incident to the metabolism studies when the child was fed on a low protein diet. Attention should be called to the remarkable similarity of results

TABLE 4.—SHOWING ENERGY METABOLISM-

Obs. Day and No.	Period No.*	Weight of Gm.	Surface Area per Sq. Meter y=mx+b (Howland)	Kind of Food	Distribution of Cal. in Food	Cal. per Kilo.	Cal. in Last Feeding	Cal. in Food in 24 Hr
2	1	4,390	0.2850	Albumin milk from whole milk plus dextrimaltose	P.16.7%-F.25.6%-CH.57.7%	121	56.0	448.
6	1	4,406	0.2858	Albumin milk, cream, dextrimaltose, maltose	P.15.1%-F.24:7%-CH.60.2%	74.5	43.6	327.
8	1	4,406	0.2858	Albumin milk, cream, dextrimaltose plus 5 gm. nutrose	P.21.0%-F.23.8%-CH.55.2%	68.0	55.1	297.
10	1	4,320	0.2768	Albumin milk with 15 gm. nutrose added	P.43.7%-F.29.3%-CH.27.0%	73.5	38.8	310.
10	2	4,320	0.2768	Albumin milk with 15 gm. nutrose added	P.43.7%-F.29.3%-CH.27.0%	73.5	38.8	310.
10	3	4,320	0.2768	Albumin milk with 15 gm. nutrose added	P.43.7%-F.29.3%-CH.27.0%	73.5	38.8	310.
13	1	3,761	0.2546	Double strength albumin milk from fat-free milk. No sugar added	P.56.2%-F. 0.0%-CH.43.8%	80.0	37.6	300.
13	2	3,761	0.2546	Double strength albumin milk from fat-free milk. No sugar added	P.56.2%-F. 0.0%-CH.43.8%	80.0	37.6	300.
13	3	3,761	0.2546	Double strength albumin milk from fat-free milk. No sugar added	P.56.2%-F. 0.0%-CH.43.8%	80.0	37.6	300.
12	3	4,220	0.2768	Albumin milk with 28 gm. nutrose added	P.50.1%-F.25.0%-CH.24.9%	84.0	50.4	353.
Av. of 10 sleeping periods		.....	.....	.....	P.40.2%-F.18.7%-CH.41.1%	80.8	43.4	326.

* Sleeping periods only used.

obtained from day to day when the child was studied under like conditions of food, repose, time, etc. The average of the five days establishes a metabolism on low protein of 893 calories per square meter of body surface per twenty-four hours.

The standard agrees very closely with that obtained for children under 3 months as published by Murlin and me.[11]

Table 4 gives detailed data of the sleeping hours obtained when the child was fed on a high protein diet. There were ten of these periods and the table shows the results obtained in each period as well as the average of all these periods.

It will be noted that the calories per hour gradually increased as the proportion of protein was increased, and that the average per hour for the ten sleeping hours was 12.74, and that the calories per square meter per twenty-four hours were 1,120.

Table 5 is a comparative table of the averages of the hours on low protein with those on high protein.

WHEN FED ON HIGH PROTEIN FOOD

Time Since Last Feeding	Respiratory Period	CO_2 per Hr., Gm.	CO_2 per Sq. Meter per Hr., Gm.	O_2 per Hr., Gm.	R. Q.	N in Urine in 24 Hrs., Gm.	N in Feces in 24 Hrs., Gm.	Cal. per Hr., (Calculated)	Cal. Produced in 24 Hrs.	Cal. per Sq. Meter per 24 Hrs.
min.	10:32-11:32	4.15	14.6	3.19	0.95	1.183	.2846	11.08	260.35	913
min.	10:30-11:30	4.14	14.5	3.48	0.86	1.113	.1876	11.95	283.43	992
min.	10:30-11:30	4.16	14.5	3.04	0.99	1.155	.2309	10.77	253.89	888
min.	10:38-11:38	4.04	14.6	2.97	0.99	2.367	.5182	10.46	243.92	881
ır. 38 min.	11:38-12:38	4.36	15.7	4.03	0.79	2.367	.5182	13.45	320.23	1,156
ırs. 38 min.	12:38- 1:38	4.77	17.2	4.60	0.75	2.367	.5182	15.35	362.93	1,311
min.	10:44-11:44	3.92	15.4	3.65	0.78	2.403	.6457	12.22	300.5	1,178
ır. 44 min.	11:44-12:44	4.31	16.9	3.82	0.82	2.403	.6457	12.28	306.0	1,205
ırs. 44 min.	12:44- 1:44	4.21	16.5	4.44	0.68?	2,403	.6457	14.71	347.8	1,366
ırs. 36 min.	12:36- 1:36	4.50	16.2	4.63	0.71	2.347	.6766	15.13	362.9	1,311
.....	.....	4.256	15.61	....	....	.....	.....	12.74	304.20	1,120

It will be noted that the twenty-four hours' caloric intake averaged about the same; that the proportion of protein calories in the food was raised from an average of 12.2 per cent. to 40.2 per cent. and that the resultant metabolism shows an increase of 25.4 per cent.

This confirms the work of Howland and establishes the fact that the protein of cow's milk when fed in excess of need increases the metabolism.

It is important here to discuss the effect on the infant of this increase in heat production.

Generally speaking, it has heretofore been assumed that the heat regulating mechanism of the body could take care of this additional

heat without detriment to the growing organism. The only word of caution which has been spoken has been based on the fear that during summer days when the weather is warm this additional heat could not escape. The heat regulating mechanism in the adult may well be adapted to dissipate this increased heat production, but infants whose heat regulating functions are still partially undeveloped are unable to avail themselves of the many means which the adult uses to get rid of extra heat, such as change of environment or adding to or lessening amount of clothing worn; and the habit of over-dressing babies for fear of "catching cold" tends to increase the difficulty of dissipating the heat due to this increased metabolism.

TABLE 5.—COMPARISON OF ENERGY METABOLISM AS OBTAINED ON DILUTED COW'S MILK AND WHEN FED ON HIGH PROTEIN MILK MIXTURES

	Food	Degree of Repose	Distribution of Calories	Cal. in 24 Hrs.	CO_2 per Hr., Gm.	CO_2 per Sq. Meter per Hr., Gm.	Cal. Produced per Hr. (Calculated)	Cal. Produced per Sq. Meter per 24 Hrs.	Increase Per Cent.
5 Hrs.	Low protein diet	Sleeping	P.12.2%-F.26.4%-CH.61.4%	331.4	4.01	14.1	10.78	893	
10 Hrs.	High protein diet	Sleeping	P.40.2%-F.18.7%-CH.41.1%	326.2	4.25	15.6	12.74	1,120	25.4

The cause of this increased metabolism was at one time attributed to the production of "free heat" when protein was oxidized in the body, but the latest researches of Prof. Lusk[14] show that "amino-acids even when they are not oxidized yield products of metabolism which act as stimuli to induce higher oxidation in that organism. This is a conclusive proof of a true chemical stimulation of protoplasm within the mammalian organism. It explains the specific dynamic action of protein."

Turning our attention to a study of protein retention with the view of determining whether this increased heat is due to protein ingested, protein oxidized, or protein added to the body, Table 6 shows the quantity of protein ingested, oxidized and added to the body, on each of the days when low protein was given and Table 7 shows the same data for days of high protein ingestion. Table 8 shows the averages compared, indicating an average increase of 49.4 calories on high protein, an increase in metabolism of 20 per cent.

14. Lusk: Jour. Biol. Chem., 1915, xx, 815.

Table 9 shows an increase in an individual period much above the average, this result having been obtained on the day the highest quantity of protein was fed, with an increase in the metabolism of 108 calories or 42.5 per cent., which is the greatest increase yet recorded.

TABLE 6.—PROTEIN BALANCE SHEET

Date	Type Diet	Protein in Grams			Total Calories Produced
		Fed	Oxidized	Added to Body	
3/24	Low protein	9.42	6.975	2.445	259.5
3/25	Low protein	9.48	6.870	2.610	256.7
3/26	Low protein	9.48	6.870	2.610	256.7
3/27	Low protein	11.18	9.170	2.010	256.7
4/ 1	Low protein	10.05	8.287	1.763	241.6
Average 5 hours	Low protein	9.90	7.630	2.27	254.8

TABLE 7.—PROTEIN BALANCE SHEET

Observation Day No.	Period Number	Type Diet	Protein in Grams			Total Calories Produced
			Fed	Oxidized	Added to Body	
6	1	High protein	12.5	8.13	4.37	283.4
8	1	High protein	14.7	8.66	6.04	253.9
2	1	High protein	18.2	9.17	9.03	200.3
10	1	High protein	33.1	19.03	15.07	243.9
10	2	High protein	33.1	18.03	15.07	320.2
10	3	High protein	33.1	18.03	15.07	362.9
13	1	High protein	41.3	19.05	22.25	300.5
13	2	High protein	41.3	19.05	22.25	306.0
13	3	High protein	41.3	19.05	22.25	347.8
12	3	High protein	43.3	18.90	24.40	362.9
Average	10 hours	High protein	31.1	15.6	15.5	304.2

In Table 10 it will be noted that in each of the two periods the same amount of heat was produced and practically the same amount of protein was oxidized. There were also different quantities of protein ingested as well as vastly different quantities of protein added to

the body. In each of these periods there was an increase of metabolism of 42.5 per cent. over the heat produced on "low protein" as already shown in Table 9. If this increase in heat production were dependent either on the amount of protein ingested or on the quantity

TABLE 8.—PROTEIN BALANCE SHEET

Length of Observation	Type Diet	Protein in Grams			Total Calories Produced	Increase in Metabolism*	
		Fed	Oxidized	Added to Body		Calories	Per Cent.
Av. 5 hours...	Low protein	9.90	7.630	2.27	254.8		
Av. 10 hours..	High protein	31.1	15.6	15.5	304.2	49.4	20.0

* The per cent. of increase is here figured on the absolute increase regardless of weight or surface area, hence is lower than when figured on basis of square meter of surface.

TABLE 9.—PROTEIN BALANCE SHEET

	Type Diet	Protein in Grams*			Total Calories Produced	Increase in Metabolism	
		Fed	Oxidized	Added to Body		Calories	Per Cent.
Av. 5 hours...	Low protein	9.90	7.630	2.27	254.8		
12th day	High protein	43.3	18.90	24.40	362.9	108.1	42.4

* Only the third hour is used in computing, as the first and second hour child was restless. This is the highest increase in metabolism due to protein yet recorded.

TABLE 10.—PROTEIN BALANCE SHEET

No. of Observation	Type Diet	Protein in Grams*			Total Calories Produced	Increase in Metabolism	
		Fed	Oxidized	Added to Body		Calories	Pro-tein
10	High protein third period	33.1	18.03	15.07	362.9		
12	High protein third period	43.3	18.9	24.4	362.9		

* These figures show that the increase in metabolism arises from protein oxidized rather than protein added to body. It will be noted that "Protein Oxidized" and "Calories Produced" are the same, while amount "Added to Body" is much increased.

of protein added to the body, then the two periods would have differed in heat produced, but the heat produced being the same in each it is evident that the quantity of protein oxidized is the determining factor in the increased heat production. Therefore it follows that the metab-

olism of protein necessary for growth or for replacement of "wear and tear" of tissue are not factors in producing this additional heat, but the increase is due to the protein oxidized as shown in Table 10. Since, according to Rubner, all protein not necessary for growth and repair is oxidized, one might conceive that such excess of protein because of its stimulating effect on metabolism might become a positive detriment to the organism. Frequently by reason of the increased metabolism more heat was given off than was supplied in the intake of energy, thus causing the organism to draw on its stored-up supply of energy, as shown in Tables 11, 12 and 13.

Table 11 shows the proportions of the various foodstuffs ingested and metabolized when fed on low protein food. It will be noted particularly that 77.3 per cent. of the protein intake was oxidized and that 86.7 per cent. of the fat and carbohydrate intake was metabolized.

Table 12 shows the same information when the child was fed on high protein.

Table 13 shows a comparison of the averages of the two preceding tables and reveals one of the most interesting facts of this paper. It will be noted that the daily caloric intake on the two diets was about the same, viz., 331 and 326 calories; that the proportion from protein was so much increased that it reduced the caloric intake from fat and carbohydrate, viz., 198.2, considerably below what was being regularly metabolized under low protein feeding, viz., 225. The amount of calories, however, derived from the metabolism of fat and carbohydrate under high protein feeding remained practically the same, viz., 234, as under low protein feeding. In other words, there were 198 calories fed and 234 oxidized. Where, then, did these other 36 calories come from? Undoubtedly from body glycogen and fat.

This shows particularly well in Table 12 on the thirteenth day when there were but 131.5 calories in the food derived from fat and carbohydrate, and yet there were 233.5 calories produced from the oxidation of fat and carbohydrate in the body, or 102 calories more than fed. It seems clear from this that when protein is ingested in high proportions with fat and carbohydrate in relative low proportions, the metabolism process required a certain minimum to be supplied by fat and carbohydrate, and when not supplied, the calories required over and above those ingested must be drawn from the stored up fat and glycogen. In other words, protein food when given in excess, stimulates the infant's metabolism to such an extent that the energy

TABLE 11.—Foodstuffs Ingested and Metabolized on Low Protein Diet

Child Fed on Low Protein Diet		Total Food Calories			Protein							Fat and Carbohydrate					
					In Food			Metabolized				In Food		Metabolized			
Day	Period	Intake	Metabolized	Per Cent. of Intake	Calories	Gm.	Per Cent. of Total	Calories	Gm.	Per Cent. of Protein Intake	Per Cent. of Total Food Intake	Calories	Per Cent. of Total	Calories	Per Cent. of Intake of F. & CH.	Per Cent. Derived From	
																Fat	CH.
3/24	1	351	259.5	73.9	38.61	9.42	11	31	6.97	74	11.9	312.3	89	228.5	88.1	20.4	79.6
3/25	1	324	256.7	79.2	38.88	9.48	12	30.5	6.87	72.5	11.9	285.1	88	226.2	88.1	18.7	81.3
3/26	1	324	256.7	79.2	38.88	9.48	12	30.5	6.87	72.5	11.8	285.1	88	228.7	88.2	17	83
3/27	1	320	256.8	80.3	45.84	11.18	14.3	40.75	9.17	81.9	15.8	274.2	85.7	228.5	84.2	18	82
4/ 1	1	338	241	71.3	41.21	10.05	12.2	36.83	8.29	82.4	15.2	296.8	87.8	214.8	84.8	0.0	100
Aver. of five sleeping periods		331	255	77	40.7	9.90	12.3	33.9	7.6	77.3	13.3	290.3	87.7	225	86.7	14.8	85.2

TABLE 12.—Showing Metabolism of Foodstuffs on High Protein Feeding

Child Fed on High Protein Diet		Total Food Calories			Protein							Fat and Carbohydrate					
					In Food			Metabolized				In Food		Metabolized			
Day	Period	Intake	Metabolized	Per Cent. of Intake	Calories	Gm.	Per Cent. of Total	Calories	Gm.	Per Cent. of Protein Intake	Per Cent. of Total Food Intake	Calories	Per Cent. of Total	Calories	Per Cent. of Intake of F. & CH.	Per Cent. Derived From	
																Fat	CH.
2	1	448.1	260.35	58.1	74.6	18.2	16.7	40.75	9.2	56.4	15.6	373.5	83.3	219.6	58.8	0.0	100.0
6	1	327.3	283.43	86.6	49.1	12	15.1	36.13	8.1	73.6	12.7	278.1	84.9	247.3	81.0	43.2	56.8
8	1	297.7	253.89	85.3	62.3	14.7	21.0	38.49	8.6	61.7	15.2	235.4	79.0	215.4	91.5	0.0	100.0
10	1	310.7	243.92	78.4	135.9	33.1	43.7	80.13	18.0	59.0	32.8	174.8	56.3	163.8	93.8	0.0	100.0
10	2	310.7	309.2	100.0	135.9	33.1	43.7	80.13	18.0	59.0	25.0	174.8	56.3	240.1	137.0	74.8	25.2
10	3	310.7	362.93	117.0	135.9	33.1	43.7	80.13	18.0	59.0	25.0	174.8	56.3	282.8	162.0	88.9	11.1
13	1	300.8	300.5	100.0	169.3	41.3	56.2	84.66	19.0	50.0	28.1	131.5	43.8	215.9	164.0	0.0	100.0
13	2	300.8	306.0	102.0	169.3	41.3	56.3	84.66	19.0	50.0	27.7	131.5	43.8	221.4	168.0	59.5	40.5
13	3	300.8	347.8	115.0	169.3	41.3	56.2	84.66	19.0	50.0	24.3	131.5	43.8	263.2	200.0	100.0	0.0
12	3	353.9	362.9	102.0	177.4	43.3	50.1	83.99	18.0	47.3	23.1	176.5	49.9	278.8	159.0	100.0	0.0
Average ten periods		326.2	304.2	93.2	127.7	31.1	40.3	69.37	15.6	54.3	22.9	198.2	59.7	234.8	118.5	46.64	53.36

TABLE 13.—Metabolism of Foodstuffs

	Total Food Calories			Protein							Fat and Carbohydrate					
				In Food			Metabolized				In Food		Metabolized			
	Intake	Metabolized	Per Cent. of Intake	Calories	Gm.	Per Cent. of Total	Calories	Gm.	Per Cent. of Protein Intake	Per Cent. of Total Food Intake	Calories	Per Cent. of Total	Calories	Per Cent. of Intake of F. & CH.	Per Cent. Derived From	
															Fat	CH.
Low protein diet, average of five sleeping hours.....	331	255	77.0	40.7	9.90	12.3	33.9	7.6	77.3	13.3	290.3	87.7	225	86.7	14.8	85.2
High protein diet, average of ten sleeping hours.....	326	304	93.2	127.7	31.1	40.3	69.37	15.6	54.3	22.9	198.2	59.7	234	118.5	46.6	53.4

liberated from the increased protein metabolism may be insufficient to furnish this increase in the heat production of the organism. Howland's work showed similar results.

In a study of the output of urinary nitrogen, Table 14, it will be interesting to note that during the low protein periods the average retention was 25.4 per cent. of the intake, while during the days on high protein feeding the retention was increased to 46.8 per cent. of the intake, which showed, therefore, a great relative as well as actual retention.

TABLE 14.—SHOWING NITROGEN RETENTION

Date	N in Food	N in Feces	N in Urine	N Retained	Per Cent. of Intake
3/24	1.507	.0922	0.924	.3450	22.9
3/25	1.509	.0920	1.008	.4090	27.0
3/26	1.509	.0926	1.008	.4090	27.0
1*	1.788	.1747	1.008	.5953	33.3
2	2.913	.2846	1.183	1.4454	49.6
3	1.381	.1350	.952	.294	21.3
4	1.775	.1734	.8946	.707	39.1
5	1.608	.1571	1.169	.2819	17.5
6	1.92	.1876	1.113	.6194	32.2
7	1.49	.1456	.995	.3494	23.4
8	2.3635	.2309	1.1556	.9770	41.3
9	3.382	.3303	1.7190	1.3327	39.1
10	5.304	.5182	2.367	2.4188	47.6
11	3.524	.3443	1.943	1.2367	35.0
12	6.925	.6766	2.347	3.9014	56.3
13	6.607	.6457	2.403	3.5583	53.8

* Observation began. During the last five days of the series the feees were collected and analyzed and the nitrogen content was found to be 2.515 gm. or 0.977 per cent. of the nitrogen intake. The figures for the daily fecal nitrogen are calculated on this basis for entire period.

CLINICAL IMPORTANCE OF FINDINGS

What is the clinical importance of the above findings? It is evident that greater attention should be paid to the relative and actual amount of protein in feeding formulas; particularly is this true in formulas made from whole milk, skimmed milk, buttermilk and albumin milk. Very frequently where there are signs of fermentation

these formulas are fed without addition of sugar and the proportion of protein is relatively high. For example: When whole milk, or any of its dilutions, is fed without the addition of sugar, the percentage of calories arising from protein amounts to about 20 per cent.; when skimmed milk or its dilutions are fed without sugar, the protein calories amount to about 30 per cent.; when buttermilk (made from skimmed milk) is used, 40 per cent. of its calories are in the form of protein; when the original Finkelstein's albumin milk is used having percentages of fat 2.5, carbohydrate 1.5 and protein 3.0 per cent., the proportion of calories due to protein is about 30 per cent. If, as is done both in this country and abroad, albumin milk is sometimes made up from fat-free curd, then the proportion of the protein in such fat-free albumin milk reaches as high as 43.per cent. Just in proportion as sugar is added, the relative percentage of protein calories is diminished as is shown in Table 15.

TABLE 15.—SHOWING RELATIVE DIMINUTION OF PROTEIN CALORIES WHEN SUGAR IS ADDED

	Per Cent. of Formula			Calories in		Per Cent. of Calories From		
	Fat	CH.	Protein	1 Oz.	1 Liter	Fat	Sugar	Protein
Albumin milk without sugar added	2.5	1.5	3.0	12.51	417	55.8	14.7	29.5
Albumin milk with 2% sugar added....	2.5	3.5	3.0	15.27	509	45.9	30.0	24.1
Albumin milk with 5% sugar added....	2.5	7.0	3.0	18.66	622	37.4	42.8	19.8
Albumin milk with 7% sugar added....	2.5	8.5	3.0	21.12	704	33.0	49.5	17.5
Albumin milk with 10% sugar added...	2.5	11.5	3.0	24.71	827	28.1	57.1	14.8

The facts as shown above for albumin milk are also true for other types of milk. In order to bring the proportion of calories derived from protein down to 7 per cent. of total, the amount of sugar added must be considerably increased. For example, for every ounce of whole milk (fat 3.5, carbohydrate 4.5, protein 3.5) used in a formula there should be one-third ounce of sugar added. For every ounce of the top half (7 per cent. fat) one-quarter ounce of sugar should be added. For every ounce of top third (10 per cent. fat) one-sixth ounce of milk sugar should be added.

HOW DETERMINE THE PROTEIN NEED

There have been several general rules applied for determining the protein need, all of which, in the light of these researches, give a higher proportion than is necessary to supply the actual need.

The rule followed pretty generally in this country is that an infant should receive the protein contained in an ounce or an ounce and a half of whole milk per pound weight of child.

Cowie[15] gives the accompanying table (Table 16) as covering the protein requirement.

On the Continent a general rule is that one-tenth of the body weight should be given in whole milk. This, say in a child of 4,500 grams, would mean the protein of 450 c.c. of whole milk. This would require

TABLE 16.—PROTEIN REQUIREMENTS

Age	Grams Protein Per		
	Kg.	Pound	Ounce
Two weeks	1.5	.68	.0425
Three weeks	2.0	.90	.056
Four weeks	2.5	1.10	.0687
Two to twelve months	2.5-3.3	1.10-1.5	.093

15 ounces of whole milk. There are 4 calories from protein in each ounce of whole milk, so that a child weighing 4.5 kilos would receive 60 calories of protein. Estimating the total calories needed at 100 calories per kilo the protein supplied would amount to 15 per cent. of the total, which is more than twice the need. Not only is the protein too high according to these general rules, but from latest researches by Benedict and Talbot, by Murlin and Bailey[16] for new-born infants and Murlin and myself[10] for infants between 2 and 12 months, it would seem that the total energy metabolism of infants under 6 months is much lower than that of infants between 6 months and 1 year. Murlin and I[10] collected data showing that the average metabolism of fourteen infants up to and including 4 months of age was 35.4 calories per square meter per hour; the average of seven infants

15. Cowie: AM. JOUR. DIS. CHILD., 1912, iv, 360.
16. Murlin and Bailey: Proc. Soc. Exper. Biol. and Med., 1914, xi, 109.

from 6 to 12 months inclusive was 41.9 calories per square meter per hour. Instead, therefore, of feeding 100 calories per kilo under 6 months, and from 70 to 80 calories per kilo from the sixth to twelfth month, the figures should be reversed and 70 or 80 calories per kilo should be fed under 6 months and 100 calories per kilo between 6 and 12 months. Further observations, however, should be made before such a radical change is recommended.

The protein need would therefore be much more nearly supplied if one-half the quantity outlined in these general rules were used, viz., ¾ of an ounce of skimmed, whole or top milk per pound weight of infant, or 1/20 of body weight in skimmed, whole or top milk. This coupled with the rules regarding the use of sugar would enable one easily to determine the need and supply it along with other food elements. Take for example a child weighing 12 pounds. Its protein need is supplied by ¾ ounce of milk per pound; hence the child should receive 9 ounces of milk. If this were supplied in the form of whole milk it would be necessary to add to it 3 ounces of milk sugar (or sugar and starch) and diluent sufficient to supply its fluid need. In the 9 ounces of whole milk there would be 180 calories and in the 3 ounces of sugar and starch there would be 360 calories, making in all 540 calories, 36 of which are from protein. A child of 12 pounds needs about 540 calories daily; hence we have both its protein and its calories need supplied.

I have followed the method of feeding low protein for the past three years and it is my belief that children do better, since the method allows the giving of much larger quantities of carbohydrates and fats without overfeeding the child, and readily permits the use of top, whole, skimmed or buttermilk formulas according to the clinical indications of each individual infant. Where large quantities of milk are fed it is necessary to feed relatively low proportions of carbohydrates if one attempts at all to approximate the caloric need.

The foregoing statements are not intended to discourage the use of albumin milk or skimmed or buttermilk without additions of sugar over short periods of time when one desires to secure the therapeutic effect of a food relatively rich in protein and calcium for the purpose of controlling diarrheas, as outlined in an article by Wilcox and Hill.

It is also recognized that every child is a law unto itself in the matter of feeding; particularly is this true in its relation to fat and

carbohydrate food, but it would seem that the supply of protein is a much more fixed quantity, since growth of tissue is much more dependent on it than on either fat or carbohydrate.

A series of clinical records are being collected covering cases fed on low protein and will be published separately.

SUMMARY OF FINDINGS

1. Protein when fed in excess of need causes an increase in the energy metabolism.

2. The increase is in proportion to the amount of protein oxidized, and not to the amount of protein added to the body.

3. Protein when fed in excess does not reduce the amount of fat and carbohydrate metabolized, but the fat and carbohydrate need remains fairly constant, and unless the minimal need of fat and carbohydrate is supplied in the food the organism will draw on its stored-up fat and glycogen to supply the difference between the amount fed and that which is metabolized.

4. When protein is fed greatly above its need it tends to produce a condition of stupor which assumes serious proportions if such feeding is continued. This stupor gradually disappears as protein is reduced in the diet. This condition is best considered as a protein food injury and constitutes a clinical entity as definite in its symptomatology as that which arises from too prolonged use of a rich carbohydrate diet.

5. The protein need of the growing infant is supplied when 7 per cent. of its caloric need is furnished in protein calories.

6. A general rule which will approximate the protein need is to furnish ¾ ounce of whole, skimmed or top milk, per pound weight of child, or if the metric system is applied, 1/20 of the body weight in skimmed, whole or top milk.

7. To keep the protein calories in any formula approximately 7 per cent. of the total, the following rule regarding the addition of sugar or cereal gruels or both may be followed: For each ounce of whole milk add ⅓ ounce of sugar or cereal.[17] For each ounce of top 16 ounces (7 per cent.) milk add ¼ ounce of sugar or cereal. For each ounce of top 10 ounces (10 per cent.) milk add 1/6 ounce of sugar or cereal.

17. The amount of cereal is estimated by the quantity of the dry cereal used in making the cereal diluent.

8. It is clearly recognized that rules outlined for feeding for nutritional purposes only cannot be followed when one feeds a food for therapeutic as well as nutritional purposes, hence the feeding of albumin or skimmed milk, i. e., a high protein food, is justified on the ground of its being a therapeutic measure and should be discontinued when the therapeutic indication no longer exists.

DISCUSSION

DR. HOWLAND: This work is interesting as showing the deleterious effect of high protein. Other studies have not shown a positive bad effect from this. In some work I did four years ago I was able to show that protein not only produces an excess of heat, by being itself consumed, it being impossible to store more than a certain amount of it in the body, but that it also acts as a stimulant to general metabolism. I have made some unpublished observations on an infant who received large amounts of protein. Breast milk was given and the mineral metabolism studied for two or three periods. It was always positive. There was a retention of sodium and potassium, calcium, phosphorus, chlorin, etc. Then the same food was given with a large amount of nutrose added. Despite this, and despite the excess of phosphoric and sulphuric acids thus produced, there was still maintained a positive mineral balance; so that from the mineral balance it was impossible to show that 20 grams of protein a day had an injurious effect. This work of Dr. Hoobler is interesting in that it shows scientifically that protein in large amount is deleterious.

DR. TALBOT: I am much interested in this report of Dr. Hoobler. It is a curious fact that when protein is increased in raw cow's milk, as it was in an instance in which we studied the metabolism, the visible symptoms of protein indigestion become apparent much sooner than when other forms of protein are used. I do not know why that should be. I tried to repeat this piece of investigation, and found that when we got the protein up to 4 per cent. the baby had symptoms of indigestion. The period in which we expected to get the most striking results was, of course, lost because some of the food was vomited.

I should like to ask Dr. Hoobler how he explains the figures here. Am I right in assuming that these were all successive periods on the same food and day?

DR. HOOBLER: Yes, sir.

DR. TALBOT: I should like to know how Dr. Hoobler explains the fact that there is a difference of 50 per cent. in the baby's metabolism on the same food, if the baby was absolutely quiet, and the metabolism was minimum. There are no records or notes of the degree of muscular activity.

DR. HOOBLER: There were a great many other points that could not be brought out at all; and they cannot be, except after a long and careful study of work of this kind.

To answer specifically, as well as I can, I might say that in nearly all the estimations by hours, it is the experience that the first hour is a low hour for metabolism; the second, higher, and the third hour, still higher. Dr. Howland

has shown, I think, a gradual increase from hour to hour. Why we should have the low metabolism of 8.01 in a first hour on high protein which is lower than that for the sleeping hours on low protein, I do not know. A possible explanation is that it takes a certain length of time for the amino-acids of the protein to become split, and that until thus split they cannot act as a stimulant to metabolism.

STUDIES IN THE ADAPTATION OF AN ARTIFICIAL FOOD TO HUMAN MILK*

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INTRODUCTION BY H. J. GERSTENBERGER

In 1910, the physiologist, Friedenthal[1] again picked up the threads which led to the ideal set up by the pediatrist Biedert a generation ago; namely, to the production of an artificial milk similar in all its important characteristics to the best food for the human infant, namely, breast milk. By not getting the results that it had expected from mixtures which took into consideration the quantities of protein, lactose, and fat in human milk, the pediatric world became discouraged and considered the production of an artificial human milk that would give good practical results a hopeless task. Friedenthal gathered courage for another attempt for the solution of this important and interesting problem from the fact that the salt content and the physical-chemical characteristics of human milk had been entirely neglected, and also from the conviction that these were important, if not the most important individual factors to be considered in the making of an artificial food that was to be similar to breast milk and which would give satisfactory results. Müller and Schloss,[2, 4] and Helbich[3] had also

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* From the Babies' Dispensary and Hospital, the Departments of Pediatrics, Chemistry and Biochemistry of Western Reserve University, and from the Walker-Gordon Laboratory, Cleveland, Ohio.

* For the apparatus, the materials and help used in making G-R milk, we are indebted to the Walker-Gordon Laboratory, Cleveland, Ohio.

1. Friedenthal, H.: Ueber die Eigenschaften künstlicher Milchsera und ueber die Herstellung eines künstlichen Menschenmilchersatzes, Zentralbl. f. Physiol., 1910, xxiv, 687.

2. Müller, Erich, and Schloss, Ernst: Die Versuche zur Anpassung der Kuhmilch an die Frauenmilch zu Zwecken der Säuglingsernährung, Jahrb. f. Kinderh., 1914, lxxx, 42.

3. Helbich, H.: Die Bedeutung der Molkenreduktion für die Ernährung junger Säuglinge, Jahrb. f. Kinderh., 1910, lxxi, 655.

4. Schloss, E.: Ueber Säuglingsernährung, Berlin, 1912, S. Karger.

independently of Friedenthal begun with the attempt to come closer to the composition of breast milk. They received their stimulus from Finkelstein's theory of the injuriousness of the whey of cow's milk. Their first object, therefore, was to modify by reduction the deleterious whey of cow's milk. They, however, encouraged by the favorable results that they had had in their institution with high fat milks, also attempted to simulate more accurately than heretofore the composition of breast milk. Schloss stated in his address at the Königsberger meeting of the Gesellschaft für Kinderheilkunde in 1910, that he and his co-workers were convinced that the road that they were following would ultimately lead to the solution of the problem of the producton of an adequate artificial food. So while they had visions of accomplishments along this direction, Friedenthal[1] had already, from theoretical grounds, worked out a plan according to which a more complete adaptation of an artificial food to breast milk could be obtained. In his article Friedenthal states that artificial woman's milk ought to contain 0.7 per cent. casein, 0.8 per cent. albumin and globulin, 7 to 8 per cent. milk sugar, 3½ per cent. fat, ash, a freezing point of —0.56, degrees electrical conductivity of 23×10^{-4} at 18 degrees, neutral reaction (H Ion Content 5×10^{-8}) besides traces of nuclein, lecithin and albuminoids, and have the proper energy content. Friedenthal further states in a later contribution (note 20) that the correlation of the salt components is of greater importance than is the total ash content.

Schloss[2, 4] then tried out Friedenthal's milk but did not get satistory results and, therefore, again modified this product. Schloss, in order to have more accurate data as to the ash composition of human and cow's milk, himself made analysis. The analyses on breast milk made by Schloss are of great value because he was the first to use samples of twenty-four hour quantities of breast milk for his determinations. In addition, he took samples of a mixed milk composed of full twenty-four hour specimens of eight women. The analyses that he got differed from those accepted up to that time. His further work, therefore, was based on the more dependable, analytical figures obtained by himself in this manner. Schloss,[4] however, felt that the poor results that he had obtained with Friedenthal's milk were due mainly to the lactose content, and he therefore replaced this with the preparation containing maltose and dextrin, and oftentimes in addition cornstarch. He also added a proprietary preparation of sodium caseinate to bring up the protein content.

By making these changes Schloss really left the road that leads to the complete adaptation of an artificial food to woman's milk, and, therefore, Friedenthal's milk, although based on less accurate analytical data, comes closer to the accomplishment of this ideal than does Schloss' milk.

Bahrdt[5] reports favorably his experience with the feeding of this milk in eighty-one cases. He states that at least among the children of the Kaiserin Augusta Victoria-Haus, Friedenthal's milk promises better results than those obtained with mixtures of simple dilutions with carbohydrate additions. Although the analytical and the metabolism work presented in his article has been seemingly justly criticized by Müller and Schloss,[2] this fact does not necessarily disprove the good clinical results obtained by Bahrdt. It was the writer's impression when he in 1913 personally conversed with Bahrdt regarding his results with Friedenthal's milk that this food did really give good results and did mean a distinct addition to our means. Both in the personal conversation and in the article which Bahrdt published later, he emphasized the nearly universal presence of vomiting and marked spitting and of dyspeptic stools in most of the infants fed with this food.

This fact, together with the interesting and important experimental data obtained by Huldschinsky,[6] namely, (1) that the stomach of infants fed with human milk contains very small amounts of the low volatile fatty acids; (2) that the stomach of infants fed with cow's milk contains three to six times as much; (3) that the amount of the low volatile fatty acids found in the stomach of babies fed with cow's milk corresponds to the amount of fat in the milk; and (4) that the formation of these free low volatile fatty acids in the stomach of a healthy infant fed on cow's milk is caused by the splitting of the glycerids of these acids by a ferment, and that the type of the former low volatile fatty acids found in the stomach corresponds to the type existing in a preformed state in the milk fat, led me to believe that probably the qualitative differences between cow's milk fat and breast milk fat were to blame, in a large measure at least, for the excessive spitting, vomiting, and dyspeptic stools.

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5. Bahrdt, H., Bamberg, Edelstein, Hornemann: Ernährungsversuche mit Friedenthalscher Milch, Ztschr. f. Kinderh., Orig., 1914, x, 303

6. Huldschinsky, K.: Untersuchungen über die Pathogenese der Verdauungsstörungen im Säuglingsalter; Mitteilung, V.: Ztschr. f. Kinderh., Orig., 1912, III, 366.

It is a recognized fact that cow's milk fat contains many more of the low volatile fatty acids than does breast milk fat (10 per cent. to 1.6 per cent. Langstein and Meyer[7]), and there are those—Bokai,[8] Bahrdt,[9] Czerny,[10] and others—who believe that the low volatile fatty acids play an important part in the production of acute nutritional disturbances in infants. While Bahrdt[11] states that Huldschinsky's findings of the abscence of an increase in the low volatile fatty acid content in the stomach of infants ill with acute nutritional disturbances speak against the importance of the low fatty acid content of infants' stomachs, on the other hand, he does believe that a disturbance of the motor and secretory powers of the stomach might alter conditions in the stomach and upper intestine in a manner that would permit the low fatty acids of the stomach contents to play an important etiologic rôle. It seemed plausible to the writer to imagine that if, for instance, the function of the pylorus could be disturbed in a manner that would permit larger quantities of food to enter the duodenum than it would under normal circumstances, that then the actual per cent. of low volatile fatty acids in the stomach contents at the time might be an important factor in the production of an acute nutritional disturbance and in the determining of the severity of the same, and that, therefore, the relatively large per cent. of low volatile fatty acids in cow's milk fat might be of decided etiologic importance. He therefore decided to attempt to obtain a fat, vegetable or animal, or a combination of such fats, that would give the same per cent. of the low volatile fatty acids as found in the fat of breast milk. In the first conference which I had, during December, 1913, with Dr. H. D. Haskins, Assistant Professor of Biological Chemistry at Western Reserve University, regarding this plan, the practical question of mixing such a fat with Friedenthal's

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7. Langstein-Meyer: Säuglingsernährung und Säuglingsstoffwechsel, Ed. 2 and 3, pp. 22, 23, 29 and 133.

8. Bokai, A.: Experimentelle Beiträge zur Kenntniss der Darmbewegungen. C. Ueber die Wirkung einiger Bestandteile der Fäces auf die Darmbewegungen, Arch. f. exper. Path. u. Pharmokol., 1888, xxiv, 153.

9. Bahrdt, H., and McLean, Stafford: Untersuchungen über die Pathogenese der Verdauungsstörungen im Säuglingsalter; VIII. Mitteilung, Ztschr. f. Kinderh., Orig., 1914, xi, 143.

10. Czerny-Keller: Des Kindes Ernährung Ernährungsstörungen und Ernährungstherapie, Abt. 7, p. 137, Franz Deuticke, Wien, 1909.

11. Bahrdt, H., Edelstein, F., Hanssen, P., Welde, E. F.: Untersuchungen ueber die Pathogenese der Verdauungsstörungen im Säuglingsalter; X. Mitteilung, Ztschr. f. Kinderh., Orig., 1914, xi, 416.

milk was considered. It was immediately realized that the only hope lay in the use of an homogenizer, in which I had become interested a few years previously in an attempt at the Walker-Gordon Laboratory to make a very fine curd for casein milk. It was then learned that the Belle Vernon-Mapes Dairy Company was planning to put an homogenizer in the new plant which they were building, and it was therefore decided to wait with the practical work until the homogenizer had arrived, and in the meantime finish, if possible, our theoretical plans. In the literature I came across Arnold's[12] work, "*Ueber Frauenmilchfett,*" in which he makes a statement that it is possible to make out of a mixture of 14 per cent. cocoanut oil and 86 per cent. lard, of the following characteristics:

	Cocoanut Oil	Lard
Refraction	35.1	47.7
Saponification number	259.0	197.5
Reichert-Meissl number	9.0	0.4
Iodin number	8.5	53.0
Polenske number	15.8	0.15

a fat that would give a refraction, saponification number, Reichert-Meissl number, iodin number, and Polenske number, very close to that of the fat of breast milk. It was decided, therefore, to use these data in the experimental and clinical work as soon as the homogenizer had arrived. While we were waiting, Niemann's[12] article on "Ueber die Möglichkeit einer Fettanerreichung der Säuglingsnahrung," appeared. He evidently had in mind the same goal as I, but had decided to reach it over another route, namely, over that of washed butter. Inasmuch as he claimed in his article to get an adequate removal of the low fatty acids from the butter by washing it with water, and also by vigorous stirring of a heated mixture an adequate and permanent emulsion of fat, together with Drs. Haskins and Ruh, I set myself at work to carry out Niemann's suggestion regarding the freeing of butter from the low volatile fatty acids with the idea of adding this fat to Friedenthal's milk. We hoped that by heating and vigorous stirring we were to accomplish the same permanent emulsification that Niemann[13] had obtained, with what results will be stated later.

12. Arnold, W.: Ueber Frauenmilchfett, Ztsch. f. Untersuch. d. Nahrungs- u. Genussmittel, 1912, xxiii, 433.

13. Niemann, Albert: Ueber die Möglichkeit einer Fettanreicherung der Säuglingsnahrung, Jahrb. f. Kinderh., 1914, lxxix, 274.

The work of Funk[14] regarding vitamines, and his theory on the etiology of rickets, the work of Osborne and Mendel,[15] Peiser[16] and Bruning[17] on the growth value of the various food substances, especially fats, the work of Hess[18] on scurvy, the findings of Bahrdt,[7] Edelstein and Csonka[19] regarding the iron content of human and cow's milk, the theories of Friedenthal[20] regarding the need of sufficient *"Bausteine der Kernstoffe,"* are all of the greatest importance to the solution of the problem of a more perfect and complete adaptation of an artificial food to human breast milk, and must receive full consideration. While various mixtures have been prepared with the object of taking into account the work of some of the authors just mentioned, the present presentation aims to confine itself mainly to the analytical, bacteriologic, physical, mechanical, practical and few clinical data obtained in the work with the preparation of our so-called G-R milk No. 2, which represents nothing more or less than Friedenthal's milk in which butter fat has been replaced with another fat having about the

14. Funk, Casimir: The Nitrogenous Constitutents of Lime-Juice, Biochem. Jour., vii, 81; Forschritte der experimentellen Beriberiforschung in den Jahren 1911 bis 1913, München. med. Wchnschr., 1913, lx, 1997; An Attempt to Estimate the Vitamine-Fraction in Milk, Biochem. Jour., 1913, vii, 211; Studien ueber das Wachstum, Mitteilung 1. Das Wachstum auf vitaminhaltiger und vitaminfreier Nahrung, Hoppe-Seylers Ztschr. f. physiol. Chem., 1913, lxxxviii, 352; Ueber die physiologische Bedeutung gewisser bisher unbekannter Nahrungsbestandteile der Vitamine, Ergebn. d. Physiol., 1913, xiii, 124.

15. Osborne, Thos. B., and Mendel, Lafayette, B.: Viewpoints in the Study of Growth, Biochem. Bull., 1914, iii; The Nutritive Significance of Different Kinds of Foodstuffs, Med. Rec., New York, 1914, lxxxv, 737. Osborne, Thos. B., and Mendel, Lafayette B.: The Influence of Butter-Fat on Growth, Jour. Biol. Chem., 1913, xvi, 423; The Influence of Codliver Oil and Some Other Fats on Growth, Jour. Biol. Chem., 1914, xvii, 401; Feeding Experiments with Fat-Free Food Mixtures, Jour. Biol. Chem., 1912, xii, 81; Further Observations on the Influence of Natural Fats Upon Growth, Jour. Biol. Chem., 1915, xx, 379.

16. Peiser, J.: Ueber Fettaustausch in der Säuglingsernährung, Berl. klin. Wchnschr., 1914, li, 1165.

17. Brüning, Hermann: Untersuchungen ueber das Wachstum von Tieren jenseits der Säuglingsperiode bei verschiedenartiger künstlicher Ernährung, Jahrb. f. Kinderh., 1914, lxxix, 305.

18. Hess, Alfred F., and Fish, Mildred: Infantile Scurvy: The Blood, the Blood Vessels, and the Diet, AM. JOUR. DIS. CHILD., 1914, viii, 385.

19. Edelstein, F., and Csonka, F. v.: Ueber den Eisengehalt der Kuhmilch, Biochem. Ztschr., 1912, xxxviii, 14.

20. Friedenthal, H.: Ueber Säuglingsernährung nach physiologischen Grundsätzen mit Friedenthal'scher Kindermilch und Gemüsepulvern, Berl. klin. Wchnschr., 1914, li, 727.

same per cent. of low volatile fatty acids as breast milk has, and having in addition other characteristics more similar to breast milk fat than to cow milk's fat. Some analytical data regarding the fats of G-R milk Nos. 3, 4, and 5 will also be presented as well as the experience of the authors with butter washed according to Niemann.

PART I

Homogenization

A. Homogenizer.—The machine procured for us by the Walker-Gordon Laboratory was a Manton-Gaulin machine with a pressure capacity for 500 kilograms. Its liquid capacity was found by us to be about 200 c.c. The pressure used by us was 250 kilograms.

B. Technic Carried Out in the Homogenization of Various Mixtures.—(*a*) Fats—butter fat, lard, cocoanut oil, cocoa butter, codliver oil: The various fats were weighed out in sterile granite dishes. The dishes with the fats were put into a steam jacketed kettle of hot to boiling water until the contents became liquid. The pans containing the fat were then emptied and drained into a larger steam jacketed kettle into which all the other ingredients of the food had been mixed. The amount of fat remaining in the pans after thorough draining was so small as to be negligible.

(*b*) Sugar: The lactose was at first added in the form of a sugar solution of 19 to 21 per cent. Later on it was found more convenient and more accurate to simply weigh the lactose in the sterile granite pan and dump it into the common mixing kettle.

(*c*) Salts: The salts were accurately weighed in a glass receptacle. The contents of the receptacle were dumped into the mixing vat and the particles adhering to the inside of the dish rinsed out with distilled water. This amount, of course, was deducted from the batch of distilled water measured for the entire quantity.

(*d*) Skimmed milk: The amount of required skimmed milk was added to the mixture in cubic centimeters. To save time different granite pitchers were carefully marked for definite amounts.

(*e*) Water: The amount of required distilled water, less 200 c.c. for the capacity of the machine, was measured in cubic centimeters and added to the mixture. To save time different granite pitchers were carefully marked for definite amounts.

(*f*) Quantity: The amount most frequently used by us for an individual batch was 30 liters.

(*g*) Mixing: 1, mixing before homogenization: Inasmuch as the largest steam jacketed kettle at our disposal could comfortably hold but 20 liters, the fat, salt, sugar, skimmed milk, and enough water to make about a total of 20 liters were put into the vat, stirred vigorously, and brought by steam heat to a temperature of 150 F. In order to avoid an excessive loss of the fat, which would occur if the mixture were allowed to go through the homogenizer undisturbed, it was necessary to keep up a constant stirring. Soon it was possible to develop a special technic in this respect that enabled a constant mixture of the fat with

the other parts of the batch. At a time when nearly all of the 20 liters had passed through the homogenizer, the remaining water was poured into the vat and run through the machine.

Recently another larger receptacle has been used for mixing all of the milk and water at one time. Out of this receptacle the milk and water mixture is run in desired amounts into the steam jacketed kettle containing the sugar, the fat, and salts. The use of this extra receptacle has lessened the time and made the practical part of the work more simple.

2. Mixing after homogenization: From the above, it will be recognized that the first part of the mixture going through the homogenizer is much more concentrated than the second part. Therefore, it is essential that a mixture of all these parts be brought about before bottling. This was managed by pouring from one can to another.

Recently we have been pouring all of the homogenized milk into the same receptacle in which the water and skimmed milk had been mixed before homogenization. This also is more simple and saves time.

(*h*) Temperature: The temperature of the mixture is brought to 150 F. before it is allowed to go through the homogenizer. It is easy to keep the batch at this temperature by regulating the steam going through the kettle and the cold skimmed milk and water coming out of the large mixing receptacle. The temperature of the milk rises about 8 to 10 degrees in the process of homogenization. During the filling, bottling, capping, etc., it drops again to about 145 to 135, and it usually enters the ice box at this temperature.

(*i*) Bottling: From the large mixing vat the milk is run into a small enamel bottling machine and filled into bottles sterilized in an autoclave. The bottles are then capped with a simple cap and with a cover cap and placed in the ice box.

(*j*) Cleanliness: All of the bottles, dishes, and utensils are sterilized in the autoclave. The mixing vat is sterilized by allowing the water to boil in it. The homogenizer is cleansed and, in all probability, sterilized by running this boiling water through it just before the homogenization of the milk is to take place. This procedure also gives one the opportunity of testing the machine for any leaks.

No more than the usual precautions are taken with the packing, shipping, etc., of the fats, sugar, skimmed milk and water.

The hands of the individuals making the milk are simply cleaned with soap and water.

The authors are aware that Friedenthal requires that the skimmed milk be not heated. They have, however, felt that for their present work, at least, it would be better and safer practically to pasteurize the finished product. In all probability there will be no difficulty when the time comes to add at least a big part of the skimmed milk in a raw state to the finished product.

PART II

Butter Fat

A. Creamery Butter.—(*a*) Cold water washing: Fresh, sweet creamery butter, in packed and in granular form, was vigorously and thoroughly rubbed and washed with some eight to ten changes of cold water. The acidity of the wash water was determined by the use of phenolphthalein and a tenth-normal

sodium hydroxid solution. The amount of acids washed out was so small as to be insignificant.

(*b*) Hot water washing: Assuming that hot water might give better results, the butter was melted and the fat separated from the curd by passing through a cheesecloth. The filtered liquid was poured, together with hot distilled water, into a large bottle. The mixture was kept hot by placing the bottle in a water-bath. After thorough shaking the bottle was replaced in the water-bath and the fat allowed to separate from the wash water, which was then siphoned off for determination of its acidity. Four washings were carried out with each batch. Records of the amounts of tenth-normal sodium hydroxid required to neutralize the acids of the combined wash waters have been lost, but it can be stated that the amounts were so small as to be absolutely insignificant, and were, in all probability, due to the presence of a small amount of free acids and also caseinogen, which was being dissolved out. Burr and Weise[21] report that fresh butter fat always has a small amount of free fatty acids in amounts that require for 10 gm. of butter 0.6 to 1.4 c.c. tenth-normal sodium hydroxid solution. The best proof that the reduction in the low volatile fatty acid content of the butter was very insignificant is the finding for the same of a Reichert-Meissl number of 28, practically the same obtained in ordinary unwashed butter.

Grimmer[22] in his abstract of Niemann's article, criticizes Niemann's procedure and states that it is impossible to wash the low volatile fatty acids out of the butter because they are present in it in the form of glycerids, just as the higher acids are, and are, therefore, not free. In other words, Grimmer's statement corresponds with our findings.

(*c*) Alcohol washing: 263 gm. of clear butter fat were removed from one pound of fresh creamery butter, 255 c.c. of redistilled alcohol were added and the materials brought to boiling under thorough mixing. The mixture was then cooled to a low temperature and the alcoholic liquid decanted from the solid fat. The solid fat was then heated until the alcohol in it had evaporated. The residue weighed 252 gm. The Reichert-Meissl value of this residue fat was 4.0, and the iodin value 38.9. The addition of 10 gm. of sesame oil to 100 gm. to this alcohol washed fat gave an iodin value of 44.3. In other words, it is possible to remove the glycerids of the low volatile fatty acids from butter fat by washing with hot alcohol. The same plan has been carried out by Hunziger and Spitzer.[23]

(*d*) Emulsification according to Niemann: Both the cold water and the hot water washed butter fat were added to Friedenthal's milk in amounts to bring the fat content up to 4.5 per cent. The mixture was brought to the boiling point and was vigorously stirred, as directed by Niemann. The results were not the same as those obtained by Niemann, for the fat on standing and cooling rose to the surface. Niemann, however, used an entirely different mixture, which contained 50 gm. of mondamin (cornstarch) to each liter of milk, and

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21. Burr, A., and Weise, H.: Ueber den Gehalt frischen Butterfettes an freien Fettsäuren und flüchtigen Fettsäuren, Molkereizeitung, Hildesheim, 1914, No. 16.

22. Grimmer, W.: Die Arbeiten auf dem Gebiete der Milchwissenschaft und Molkereipraxis im Jahre, 1914, I Semester, Monatschr. f. Kinderh., Referate, 1915, xiv, 81.

23. Hunziker, O. F., and Spitzer, G.: A Study of the Chemical Composition of Butterfat, and its Relation to the Composition of Butter, Proc. Indiana Acad. Sc., xxv, 15.

this addition to his milk mixture was, in all probability, responsible for the difference in our results.

(*e*) Clinical data: Owing to the fact that the homogenizer was a very large machine used for the homogenization of large quantities of cream and was too large and unhandy for our work, and owing also to the climatic conditions that existed at that time — heat, August, 1914 — only a few older, well babies were put on the milk simply to get a rough idea how the children would take it and react to it; that is, whether there would be an improvement over Bahrdt's[5] experiences or not. Only three older infants were put on Friedenthal's milk with cold water washed butter and two on Friedenthal's milk with hot water washed butter. Two of the former reacted with thin, yellow stools in increased numbers and one vomited severely. One of the latter reacted in the same manner. The mothers of these children were not enthusiastic about our giving their babies this "new milk" under such conditions, and we, therefore, because of this and the further reasons for limiting the number of babies in the first place, decided to discontinue our clinical investigations until the arrival of cooler weather and of the smaller homogenizer, which the Walker-Gordon Company was having made for our use. The impression that we gained from this very meager experience with Friedenthal's milk and water washed butter was that there was no improvement over the results obtained by Bahrdt with the regular Friedenthal's milk.

B. Process Butter.—Process butter was considered by us because of its cheapness and also because of the fact that it surely had ample chance to decompose and so have many of the low volatile fatty acids in a free state, which condition would enable us to remove the latter by washing the butter with water. The work with this material was soon dropped because of our inability to rid it from the very disagreeable odor.

PART III

Mixed Fats, Animal and Vegetable

A. General Statement.—As stated in the introduction, our main object was to find a fat or combination of fats that would be more similar to breast milk fat than cow's milk fat, especially regarding the low fatty acid content, and to see whether a substitution of such a fat for the cow's milk fat in Friedenthal's milk might not improve this milk and represent a further step in the more complete adaptation of artificial food to human milk.

B. Experimental Data.—The accompanying table by Arnold[12] (Table 1) directed our attention to the use of lard and cocoanut oil:

TABLE 1

FROM ARNOLD'S WORK, "UEBER FRAUENMILCHFETT"

	Cocoanut Oil	Lard	Mixture	Woman's Milk Fat, I
Refraction	35.1	47.7	47.65	47.6
Saponification number.	259.0	197.5	206.1	206.08
Reichert-Meissl number	9.0	0.4	3.0	2.65
Iodin number.....	8.5	53.0	46.77	46.25
Polenske number.....	15.8	0.15	1.65	1.65

For many reasons it seemed worth while to try to make cod-liver oil a part of this fat combination. In order to make such a mixture more palatable cocoa butter was added. We, therefore, prepared four batches of fats in the following manner:

No. 2. Lard 86.00 per cent., cocoanut oil 14 per cent.

No. 3. Lard 74.88 per cent., cocoanut oil 14 per cent., codliver oil 11.11 per cent.

No. 4. Lard 63.78 per cent., cocoanut oil 14 per cent., codliver oil 11.11 per cent., cocoa butter 11.11 per cent.

No. 5. Lard 74.88 per cent., cocoanut oil 14 per cent., cocoa butter 11.11 per cent.

It was our intention to use all four of these, but for practical reasons, after having found out that infants would take any one of them, we decided to limit our experiences for the beginning to G-R milk No. 2.

Table 2 gives first, the character numbers of the individual fats; second, the character numbers of the fats of G-R milk Nos. 2, 3, 4, and 5, obtained by calculation on the basis of the character numbers actually found for the individual fats (the individual fats were mixed by heating at 60); third, the character numbers of the fats mixed in the same proportion as they were mixed in the milk; fourth, the character numbers for the mixture of lard and cocoanut oil in the proportion as they were used in G-R milk No. 2, and heated for the same period of time as required to extract the fat from G-R milk No. 2; and fifth, the character numbers of the fat extracted from G-R milk No. 2.

TABLE 2.—DATA CONCERNING VARIOUS FATS USED

	Reichert-Meissl	Polenske	Iodin	Saponification
Lard	0.08	0.49	63.07	195.5
Cocoanut oil	6.436	13.69	8.836	259.5
Cocoa butter	0.34	0.30	36.35	196.4
Codliver oil	0.27	0.315	170.0	189.9
Mixed fats:				
(Same proportions)				
As Milk II (calculated)	0.9698	2.337	55.45	204.5
As Milk II found	1.638	1.231	55.46	206.8
As Milk II found*	2.524	1.22	.....	.....
Fat from Milk II	2.72	1.2	55.0	206.0
(Same proportions)				
As Milk III (calculated)	0.9914	2.318	66.24	203.8
As Milk III found	2.09	1.288	67.5	205.1
(Same proportions)				
As Milk IV (calculated)	1.188	2.297	63.14	204.0
As Milk IV found	2.127	1.498	64.49	205.4
(Same proportions)				
As Milk V (calculated)	0.8128	2.318	52.52	204.6
As Milk V found	1.971	1.301	52.75	206.3

* Fats in same proportion as in Milk II heated with ether for same period of time as required to extract fat from milk.

Table 2 reveals the fact that it is possible to calculate the iodin and the saponification values of mixtures of fats before or after homogenization in milk, from a consideration of these values in the individual fats. The data with equal clearness show that the Reichert-

Meissl and Polenske numbers may not be so calculated, but that the mixing of the fats produces a change in the relative amounts of soluble and insoluble fatty acids that will volatilize with steam in the time required for the determination. It is noteworthy that the total amount of the volatile fatty acids is not greatly changed, for the sum of Reichert-Meissl and Polenske numbers as found is in each case approximately the same as the sum of the calculated values. This variation is not now understood and further work will be done to determine the cause of the change in value.

The slight increase of 0.2 in the Reichert-Meissl number of the fat from G-R milk No. 2 over the mixture of the same fats in the same proportions and heated for the same period of time as required to extract the fat from G-R milk, is probably due to the 0.4 per cent. of butter fat present in the skimmed milk, as can be seen from Table 5.

By comparing the character numbers as given in Table 2 for G-R milk No. 2 with Arnold's figures for his mixture and for his woman's milk fat No. 1, it will be seen that the Reichert-Meissl and saponification numbers are nearly identical; that there is a slight difference between the Polenske numbers, and a decided difference between the iodin numbers. The difference between the iodin numbers is due to the high iodin value of the batch of lard used in our work (G-R milk, lard 63.07; Arnold, lard 53.0). By rearranging the mixture we could have procured an iodin value for the G-R milk fat which would have been closer to Arnold's figures for woman's milk fat, but by doing so we would have changed the Reichert-Meissl and the saponification numbers; but as the Reichert-Miessl value seems of first importance to us, we decided to continue to use this mixture without any further change, and it is, of course, probable that a fair increase in the iodin number above that found in woman's milk fat is of no great importance.

The following figures given by Arnold[12] for his analysis of another woman's milk fat (*Frauenmilchfett No. 2*).

Refraction	48.75
Saponification	205.0
Reichert-Meissl	1.5
Iodin	45.65
Polenske	1.45

show, as one, of course, would expect, that fat from milk coming from different women will show variances in the character numbers of their respective fats.

Merkel[24] reports the following as character numbers of a butter made from the cream of a four-day quantity of milk from a wetnurse:

Saponification number	209.3
Reichert-Meissl number	1.5
Polenske number	2.2
Iodin number	46.8
Refraction at 40°	46.3

Table 3 shows that by making use of tallow—which one might imagine from Osborne and Mendel's[15] work, might even have an added value over lard—in the fat mixture, a greater resemblance as regards iodin numbers can be obtained.

TABLE 3.—CHARACTER NUMBERS OF INDIVIDUAL FATS

	Saponification	Reichert-Meissl	Iodin
Lard	195.29	0.08	63.1
Tallow	196.6	0.5	41.4
Cocoanut oil	259.5	6.43	8.8
Cocoa butter	196.4	0.34	36.3
Codliver oil	189.9	0.27	170.0

MIXTURE WITHOUT CODLIVER OIL

	Per Cent.	Saponification	Reichert-Meissl	Iodin
Lard	50	205.48	1.07	47.36
Tallow	35			
Cocoanut oil	15			

MIXTURE WITH CODLIVER OIL

	Per Cent.	Saponification	Reichert-Meissl	Iodin
Tallow	45	205.46	1.285	45.17
Lard	15			
Cocoanut oil	15			
Cocoa butter	20			
Codliver oil	5			

Table 4 shows the materials used for a typical batch of G-R milk No. 2. The table is analyzed to show the origin of the various contributing substances:

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24. Merkel, Eduard: Zur Kenntnis des Frauenmilchfettes, Pharm. Zentralhalle, 1912, liii, 495.

TABLE 4.—MATERIALS FOR G-R MILK No. 2

	Total gm.	Per Cent. Water	Salt	Protein	Fat	Lactose
Skimmed milk	9,890	27.23	0.2184	0.96	0.132	1.463
Water	19,800	60.07	.....	....	.....	.....
KCl	27	.....	0.0819	....	.....	.....
K_2HPO_4	13.5	.....	0.0409	....	.....	.....
KH_2PO_4	13.5	.....	0.0409	....	.....	.....
Lard	1,274.5	.....	.....	....	3.867	.....
Cocoanut oil	207.5	.....	.....	....	0.629	.....
Lactose	1,740	0.0425	.....	....	.....	5.235
Totals	32,966	87.34	0.382	0.96	4.628	6.698

The distribution of the substances from the skimmed milk shown in Table 4 is based on the analysis of the milk used, shown in Table 5.

TABLE 5.—DISTRIBUTION OF SUBSTANCES FROM SKIMMED MILK

SKIMMED MILK JUNE 18
Water 90.51
Ash 0.728
Protein 3.2
Fat 0.44
Lactose 4.87

The composition and characters of the G-R milk No. 2 prepared from the batch given in Table 4, as determined by analysis, are summarized in Table 6.

TABLE 6.—COMPOSITION AND CHARACTER OF G-R MILK No. 2

ANALYSIS
Water 87.21
Ash 0.378
Protein 0.93
Fat 4.617
Lactose 6.65

General characters: Specific gravity 15.5°, 1.032; specific conductivity 20°, 3.41×10^{-3} recip. ohms; freezing point depression 0.618°; caloric value per kg., 739.6 cal.

Characteristics of fat content: Size fat globules, 0.2-1 micron; brownian movement vigorous; Reichert-Meissl value, 2.72; Polenske number, 1.2; iodin number, 55.0; saponification number, 206.0.

That the milk maintained the same general composition may be judged from the accompanying analyses made at different periods (Table 7).

TABLE 7.—ANALYSIS OF G-R MILK No. 2, AT DIFFERENT PERIODS

	May 18	May 20	June 5	June 18
Water	86.8	87.14	87.44	87.21
Ash	0.43	0.37	0.37	0.378
Protein	1.1	0.97	0.91	0.93
Fat	4.52	4.58	4.6	4.617
Lactose	7.07	6.63	6.51	6.65

The somewhat low protein and lactose content is due, in a part at least, to the fact that the milk was added as grams instead of c.c.

TABLE 8.—BACTERIAL COUNTS FOR SKIMMED AND FINISHED MILKS

Date		Count	Skim, Count
May 6	No. 2 II	Sterile	.....
May 6	No. 2 III	Sterile	.....
May 6	No. 2 IV	Sterile	.....
May 6	No. 2 V	Sterile	.....
May 12	No. 2 II	3,100	.....
May 12	No. 2 III	5,000	.....
May 12	No. 2 IV	16,100	9,850
May 19	No. 2	1,850	.....
May 20	No. 2	4,500	55,300 *
May 21	No. 2	6,000	91,000 *
May 22	No. 2	Sterile	11,300 *
May 24	No. 2	Sterile	19,700 *
May 25	No. 2	Sterile	.....
May 26	No. 2	Sterile	39,000 *
May 27	No. 2	Sterile	5,500 *
May 31	No. 2	Sterile	.....
May 29	No. 2	4,900	.....
June 2	No. 2	1,000	2,400
June 4	No. 2	Sterile	7,200
June 5	No. 2	300	8,400
June 7	No. 2	Sterile	157,200
June 9	No. 2	Sterile	6,800
June 11	No. 2	1,700	4,500
June 12	No. 2	9,000	2,000
June 14	No. 2	3,100	42,000
June 16	No. 2	Sterile	70,000
June 19	No. 2	200	3,200
June 20	No. 2	700	400
June 25	No. 2	200	300
June 26	No. 2	300	2,700

* Not certified skim.

Table 8 gives the bacteriological counts for the skimmed milk and for the finished milks, and shows on the whole very low bacterial counts for the prepared milk. These excellent results are, in all probability, due to the fact that, unknowingly, practically the same technic and conditions were established by us as advocated by Ayers and Johnson.[25]

Analytical Methods.—Water, Ash, Protein: The methods used for determining water, ash and protein are those of the A. O. A. C. described in Bulletin 107 of the Department of Agriculture.

Fat: The usual methods for fat extraction and estimation are completely unreliable with homogenized milk of this type. When the Babcock centrifugal method is used a definite separation of fatty from acid layer cannot be obtained.

25. Ayers, S. H., and Johnson, W. T., Jr.: Pasteurization in Bottles and the Process of Bottling Hot Pasteurized Milk, Jour. Infect. Dis., 1914, xiv, 217.

Various determinations were made by the Adams paper coil method, and the following figures obtained on milk that by more accurate analysis was shown to contain 4.5 per cent. of fat: 3.75, 3.69, 3.34, 2.24 per cent. A modification of the Werner-Schmidt acid method yielded fairly close results, but very great difficulty was experienced in securing a separation of the acid and ether layers. The Roese-Gottlieb process was then employed, and it was found that excellent results can be obtained when low-boiling petroleum ether (35 C.) is used, and the second and third extractions accomplished by inversion, without shaking, of the mixture. The above recorded analyses substantiate the accuracy of this method.

Method of Fat Extraction from Milk: 150 c.c. of milk were diluted with 250 c.c. water, and 9 c.c. of 1 per cent. sulphuric acid added, with constant stirring. A cylindrical cup made from fat-free filter paper was fitted closely into a Buchner funnel and after moistening the paper the acidified mixture was filtered. After normal filtering had ceased, the filtrate was discarded and suction applied until most of the water was removed. This final filtrate was shaken with ether, and the ether subsequently used for the extraction of the fat from the precipitate. The filter paper with precipitate was transferred to a mortar and ground with about 20 gm. anhydrous sodium sulphate, when a dry, somewhat waxy porous powder resulted. This powder was placed in a Soxhlet apparatus, where extraction was complete in two hours. The ether was then driven off, or in some cases the ether solution was transferred by pipet to the vessel in which a determination was to be made.

Reichert-Meissl Value: Leffmann and Beam's saponification method was used, and the distillation continued thirty minutes.

Polenske Number: Glycerol saponification was used, and the condenser tubes washed three times with water, then three times with alcohol.

Iodin Number: The Wjis method was used.

Saponification Number: One gm. of the fat was saponified with 5 per cent. potassium hydroxid in specially purified alcohol. It is of importance that the blank determination be heated on the water bath for the same period of time as the regular determinations.

Size of Fat Globules: The value of 0.2 to 1 microns was roughly approximated by the use of Thoma's hemacytometer. The fat globules exhibit remarkable uniformity of size, and all show vigorous brownian movement.

Lactose: The solid lactose used was examined both polarimetrically and by reduction, and found to be 99.2 per cent., $C_{12}H_{22}O_{11}.H_2O$. Lactose in milk was determined in each case by the polarimeter, using acid mercuric nitrate for precipitation, and estimating the solids by the method of double dilution. To check the polarimetric method, the milk analyzed on June 18 was determined also by the reduction method, using Soxhlet's modification of Fehling's solution, weighing the copper as cupric oxid, and calculating lactose from the Soxhlet-Wein tables. The results show the absence of any substances in the milk that would vitiate the accuracy of the polarimetric method.

Per cent. lactose by polariscope 6.51
Per cent. lactose by reduction 6.537

Specific Gravity: Quevenne's lactodensimeter was used at 15.5 C.

Conductivity: Conductivity was measured by the Kohlrausch method, using a cell with electrodes about 1 cm. apart and 2.5 cm. in diameter.

Depression of Freezing Point.—The determination was made by the usual method. It is highly important that the temperature of the freezing mixture be not lower than about —1.5 C. as the concentration of the solution by the settling out of ice changes the f. p. significantly.

Calorimetry: To determine the heating value, 2 c.c. of milk were accurately weighed in a small combustion cup. This was placed in a desiccator equipped with shelves holding dishes filled with calcium chlorid. Evacuation was accomplished by a water pump, and in twenty-four hours the material had dried and showed no evidence of loss by spattering. The dried milk was then burned in a Parr bomb with 20 atmospheres oxygen pressure. The calculation of heating value from the analysis of milk reported in Table 7 (June 18) closely agrees with the direct calorimetric determination.

	CALCULATION FROM ANALYSIS	
Protein	0.93 × 5.85	5.44 C.
Fat	4.617 × 9.1	42.02 C.
Lactose	6.65 × 3.96	26.33 C.
		73.79 C. per 100 gm. milk
Obtained from calorimeter		73.96 C. per 100 gm. milk

C. Clinical Data.—(*a*) Vomiting: The clinical experience until now has not been sufficient to be considered worthy of report. It is hoped at a later time to present the clinical results. A statement, however, can be made regarding the degree of vomiting and dyspeptic stools met with so frequently by Bahrdt in his patients fed with Friedenthal's milk prepared with unchanged cow's fat. Of a list of twenty babies, from 1 week to 7 months of age, there was spitting up or slight vomiting in five. In two of these this has disappeared; in a third, the vomiting continues once a day; and in the other two there still exists a slight vomiting. Two other children showed marked vomiting before they were put on the food; the one gradually improved while on the milk, and now does not vomit at all, and the other is a case of pylorospasm which continues to vomit, but which has begun to gain in weight since it has been getting the food.

(*b*) Stools: Of the twenty children only two showed dyspeptic stools. Two were constipated and passed rather firm, somewhat formed, fatty soap stools. The remainder had what we termed normal stools. These varied in color from a lemon-yellow to an orange-yellow, were of a lard-like, pasty consistency, and contained, in most instances, smaller or larger masses of soft, fatty soaps. Many of the stools changed from a yellow to an olive-green in the diaper.

These few data suffice to prove that the vomiting has been decidedly less and the stools decidedly more normal in our children than they were in Bahrdt's, and we believe that this is due to the removal of the low volatile fatty acids. Whether the fact that the milk was homogenized has anything to do with these better results is impossible to say at the present time. Birk, according to Grulee,[26] could find no improvement in the children by homogenizing their foods. On the other hand,

26. Grulee, Clifford G.: Infant Feeding, W. B. Saunders Co., 1912.

Lavialle[27] believes that the homogenization greatly enhances the digestibility of a milk because it offers to the digestive ferments a much larger action surface, and because it causes, by reason of the marked brownian movement, the formation of currents, which are responsible for an active mixing of ferments and foods. Inasmuch as the fat in human milk does not exist in such a fine emulsion as the fat of homogenized milk, it can at least be assumed that a finer division than is present in human milk is not necessary; on the other hand, there is, at present, no reason to believe that any harm is done to the fat or any other constituent of the milk by homogenization, excepting, of course, the effect of the raised temperature on some of the constituents of skimmed milk; and it may be found that homogenization is of greater value in the production of artificial human milk than the mere mixing for which it has been used by us.

(*c*) Weight: The following figures are given to show that normal or slightly below normal infants made good gains in weight. Eighteen infants, from 1 week to 7 months of age, for a total period of seventy-three weeks, made a total gain of 10,630 gm., or an average of 145 + gm. per week.

D. Economical Data.—Friedenthal's milk made up with a mixture of fats like lard, tallow, cocoa butter, cocoanut oil, cod-liver oil, olive oil, cottonseed oil, sesame oil, and the like, can be produced at a price decidedly lower than when butter freed from a large per cent. of its low fatty acid glycerids is used. The cost of the fat per liter of various combinations with various fats, is as follows:

For a mixture of tallow 40 per cent., lard 10 per cent., cocoanut oil 20 per cent., cocoanut butter 20 per cent., codliver oil 10 per cent.	1.30 cents
G-R Milk No. 2	1.43 cents
G-R Milk No. 3	1.60 cents
G-R Milk No. 5	1.70 cents
G-R Milk No. 4	1.80 cents
Friedenthal's milk with cow's butter fat, without considering the cost of washing the butter with alcohol	3.70 cents

While the production cost of a milk for infants is not of the first importance, yet it is, nevertheless, true that there are many families who cannot get for their infants what they should have simply because of the price, and, therefore, if an adequate food can be prepared at a low cost it is an advantage that is important when it is desired that all families whose infants require it should get it. It is also interest-

27. Lavialle, P.: Le mouvement brownien dans le lait homogeneise. Clin. infant., 1913, xi, 490.

ing to think of the economy that would result in a general way by the reduction in the use of the more expensive butter and the increase in the use of fats that are distinctly cheaper.

SUMMARY

1. By mixing varying proportions of different animal and vegetable fats, it is possible to get a fat that in its Reichert-Meissl number (small per cent. of low volatile fatty acid glycerids), saponification number, iodin number, and other characters, is nearly identical with the fat of human milk, as has previously been shown by Arnold.

2. By replacing in an artificial milk cow's-milk fat with the fat of the above description in an emulsified state (homogenized), a distinct step in advance towards the more complete adaptation of an artificial food to breast milk is made.

3. It is also possible to take into consideration the "growth factors," "vitamine factors," and the like, in choosing the individual fats for an acceptable mixture. This represents a further step in the more complete adaptation of an artificial milk to human milk.

4. The homogenizer represents the important means by which the mixing and emulsification of the fat in the artificial milk is possible. The homogenizer also changes the physical condition of the fat (smaller globules, brownian movement), which may be of advantage.

5. The meager clinical data suffice to show that the infants fed with Friedenthal's milk in which the cow's-milk fat has been replaced by a fat with a low volatile fatty acid glycerid content, similar to that of human milk fat, vomit less and have more normal stools than the children reported by Bahrdt, and fed with Friedenthal's milk containing unchanged cow's-milk fat.

6. Washing butter with cold or hot water does not remove the low volatile fatty acids from butter, except in an insignificant degree.

7. Washing butter with hot alcohol does remove the low fatty acid glycerids to a decided degree.

8. The manufacture of a food like G-R milk can be arranged to give a very low bacteriologic count.

9. The production of milk like G-R milk can be made at a reasonable cost.

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HOMOGENIZED OLIVE OIL AND FAT-FREE MILK MIXTURES IN CASE OF DIFFICULT FEEDING*

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In a paper read before the New England Pediatric Society in February, 1915, I called attention to the possible application of the principle of homogenization of liquids of different densities to modified milk mixtures in infant feedings. At that time I reported some results obtained by replacing the fat of cows' milk with olive oil, the emulsion being produced by the homogenizing machine invented by M. Gaulin of Paris, the American patent of which is controlled by the Manton-Gaulin Mfg. Co. of Boston. Since then I have had an opportunity to carry out some clinical experiments in additional cases, the results of which, although the babies are still under observation, are the subject of this paper.

As the principle of the homogenizing machine is unfamiliar to many and has been applied to milk modifications in this country to a very limited extent, a few words of explanation may be in order.

Homogenization of liquids of different densities consists in reducing the constituent elements into such a physical condition that they will no longer separate, but will maintain a permanent and even composition throughout the mixture.

Briefly stated, this result is brought about by a powerful pump which forces the mixture through a finely ground agate valve against great pressure. After its passage, the mixture is perfectly homogeneous, and in the case of milk, or mixtures of milk and oils, the fat globules are crushed, torn and pulverized, and so incorporated with the other elements of the milk, that they can no longer rise by action of gravity, separate after long standing nor agglutinate.

M. Gaulin's first machine was brought out in 1899. With this, the fluid elements were forced through very fine capillary tubes, but the

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practical results were not perfect, owing to the fact that many of the fat globules passed through the smallest possible capillary tubes without alteration. M. Lindet, of l'Institut Agronomique, who had interested himself in M. Gaulin's invention, demonstrated that the ascending force of fat globules were proportionate to the cube of their radii, and that the principle of stabilization of milk consisted in reducing these radii to a dimension as near as possible to zero. The diameter of butter fat globules varies from 1/100 to 1/1000 of a millimeter, whereas the smallest hole that can be bored in a metallic surface is about 1/10 of a millimeter. This led M. Gaulin to adopt an entirely new method of carrying out his original idea, and in 1902, he announced his invention of a device which subjected the fat globules to great pressure between two surfaces, exactly adjusted to each other, but sufficiently elastic to permit the passage of the most minutely divided particles.

The essential patent in this homogenizing machine is an agate valve, so finely ground that it will leak only under great pressure, and held in its bed by a variable tension spring, which is regulated by a fly-wheel with a screw end. The mixture is pumped against a pressure which may vary up to 500 kilos. The pumps vary in capacity from 50 to 2,000 liters per hour; according to the size.

The chemical composition of the milk is in no wise affected by the process, but in cases of milk and cream mixtures, the physical condition is so changed that the fat can no longer be separated by the usual cream separators. In making the Babcock fat test, more acids must be used and centrifugal action continued for a longer time.

Homogenization improves decidedly the taste of the milk or cream, particularly that of pasteurized milk. As the process prevents the separation of the fat, homogenized creams can be readily pasteurized. When commercial milk is to be transported long distances in warm weather, and its temperature allowed to rise from lack of proper refrigeration, the continual jolting to which it is subjected causes the cream to be churned into butter fat, and it is impossible to reincorporate it into the milk in its original form. The same disturbance of emulsion may, under similar conditions, happen to milk modifications. We are all familiar with the greasy surface seen in summer in the bottles of milk brought to the clinic by the mothers who live at a distance, so that

a considerable quantity of fat is often taken into the baby's stomach in large indigestible globules.

The application of homogenization to ordinary whole milk or to any kind of milk modification, will overcome this defect, and theoretically it would seem as if it would yield a much more digestible mixture. This is one of the points I hope we shall be able to determine in the series of cases I have planned.

Variot, in Paris, has used a homogenized milk in the "Goutte de lait" de Belleville. He claims it is taken as successfully as breast milk and has never seen cases of infantile scorbutus nor rachitis which could be attributed to its use. Chevalier demonstrated by chemical analysis that the constituents of homogenized milk are more completely absorbed than those of simple sterilized milk. The more finely divided the food, the greater is its accessibility to the digestive fluids, and the greater its assimilation.

It is interesting to note also that when rennin is added to homogenized milk, the curd which results is a homogeneous flaky paste, resembling closely the curd of human milk.

Last October, while discussing various feeding problems with Mr. F. W. Howe of the Walker-Gordon Company, I first learned of this invention of M. Gaulin. The idea of utilizing it to improve the quality of ordinary milk modifications occurred to us at that time, and it required very little imagination to foresee a possible field for investigation into infant foods which may open many new lines of study. Through the kindness of Mr. Walker, and the cooperation of Mr. Howe, we were able to secure temporarily for experimental purposes one of the homogenizing machines and install it in the laboratory where it could be run by the power plant of the refrigerating apparatus.

The most interesting application of this principle of homogenization is in connection with the fat constituent of milk modifications, especially in cases of so-called "fat intolerance." One recognizes a class of feeding cases in which the fat of cow's milk, if given in too large percentages, leads to a digestive crisis of a serious nature. The restoration of the infant's tolerance for fat then becomes a very slow and gradual process. During this period the nutrition suffers severely. There are, of course, all degrees of intolerance. The milder cases may generally be corrected and controlled by careful feeding. The severe

cases often resist our best efforts and pursue an interrupted downward course. Certain of these babies are capable of digesting high percentages of carbohydrates and proteins, so that the nutrition of the body can be maintained, but others are unfavorably affected by such an unbalanced ration. Without recourse to breastmilk, many of them cannot be made to thrive.

The fact that the great majority of cases of fat intolerance occur in artificially fed infants, and the further observation that in the first year at least they generally respond favorably to breast-milk, raises the interesting question as to whether it is fat per se which causes the familiar symptom-complex or simply the peculiar qualities or reaction to some part of the fats of cow's milk. Generally speaking, breast-milk contains a much higher percentage of fat than that which has been given in the milk formula and yet under its use the symptoms gradually disappear, and metabolism is restored to its normal basis.

These considerations have led to more or less experimentation with vegetable oils and fats of other animals, such as lard, and with cod liver oil. But we have now an opportunity to combine such fats and oils with milk or milk and other ingredients in a practically perfect and permanent emulsion, so that we may reasonably expect a more efficient result from their use, not only for infants, but invalids.

If, as a matter of experiment, one can show that olive oil, for instance, is readily digested and assimilated when homogenized with skim-milk, in these cases of intolerance to cow's milk fat, one can then seek by more detailed experiments, of a more exact and scientific method, to find out what element or elements of cow's milk fat is the source of the toxic substances which seem to be formed in the processes of digestion.

One of the most striking facts which recent metabolism experiments in infants has shown is the interrelation of the various ingredients of milk in normal metabolism. A disturbance in the digestion of an element frequently influences the metabolism of the other elements, and the end result which we see in the vomiting, diarrhea, abnormal stools, malnutrition and toxemia, represents a very complex series of antecedent causes.

Now, if we can separate in a pure state and recombine into a homogeneous mixture the necessary food elements for an infant, we

have advanced to an interesting stage of experimentation to determine some of the possible primary causes which start up the train of symptoms leading to the digestive explosions so often seen in the artificially fed infants.

It is possible, for instance, by this process of homogenization to combine an almost pure olein, or palmitin, or stearin with fat-free skim milk and so eliminate almost entirely the influence of the various fats of cow's milk. By using a chemically pure precipitated casein, we can combine pure casein with pure oils and pure sugars of different varieties, adding artificially prepared mineral matter in varying proportions. Such mixtures, homogenized, may be found to be of use in exact metabolism experiments, although they would be too expensive and complicated for practical feeding.

We may combine a vegetable fat, such as olive oil, with precipitated casein, or fat-free lactic acid milk, and test its food value in acute diarrheas, or in convalescence from acute diarrheas, conditions in which the ordinary fats of milk are not well tolerated. I have had an opportunity so far to test the tolerance to olive oil in these acute infections in 3 cases only; one a convalescent from a severe infectious diarrhea, and 2 during an infectious diarrhea at the end of the first week of fever. In the convalescent case, the child, two and a half years of age, took 2 per cent. of olive oil in a fat-free lactic acid mixture and gained over a pound in four days. The case returned then to the country and I was not able to observe further its use.

In the other two cases, the 1.50 per cent. of olive oil was given in a malt soup mixture. Both children, one one year, the other three years of age, have steadily improved. As the cases are far away from Boston and the parents have no means of weighing the children, my observation of the effect of the food is incomplete, but the result at least justifies the hope that such cases can be given a food of higher caloric value by this method, with less disturbance of nutrition and greater conservation of strength. Dr. Wyman and I are planning more extensive and accurate investigations along this line, through the courtesy of Dr. Bowditch, when the material which the Floating Hospital will furnish is available.

A more practical problem at once suggests itself in the use of mixtures of olive oil and skim milk—especially in combination with the malt soup mixtures.

The type of food which one finds most useful in cases of fat indigestion with extreme malnutrition, is the malt soup mixture. Many of the worst cases are amenable to successful feeding by this method intelligently applied. However, we do meet with failures, and if we are to fairly test the applicability of an homogenized olive oil malt soup combination, we ought to select our cases from those who have been carefully fed in the past and yet failed to respond.

I have chosen olive oil for my first experiments, as olein is the principal fat of breast-milk. The economic aspect of such a mixture, it seems to me, is of immense importance. The principal cost in milk modification depends upon the value of cow's fat or cream. Olive oil even at ordinary retail prices costs about one-fourth as much as cream. If combined with fat-free milk, the cost of a modified milk could be greatly reduced for the benefit of the poor.

Another point in connection with the malt soup olive oil mixtures is the effect of the homogenizing process upon the starch. The tendency for the barley decoction to separate on standing is strikingly overcome. In fact any milk modification is improved in taste and appearance by this process of homogenization. It has been shown that whole milk so treated is more easily digested and assimilated. Homogenization of modified milks might, therefore, increase their efficiency.

In my previous paper I reported the result of 2 cases of difficult feeding in which olive oil was combined with fat-free milk, barley water and maltose. The subsequent history of these cases is included in this paper and in addition the case records of 10 others. These additional cases were selected from the outpatient clinic and were especially chosen, because of their failure to make satisfactory progress under the intelligent and careful feeding which they had received in that department. The results must be judged with this fact clearly in mind, that the previous feeding had in every case been either a failure or unsatisfactory, and the question was whether any material improvement in digestion and nutrition could be brought about by the use of an homogenized olive oil mixture, in place of the ordinary fat-free or low fat mixtures which had been in use.

The case histories have been purposely condensed, for practical reasons, the essential features only being recorded. Most of the weight charts have been plotted, showing gains or losses at intervals of two

weeks or one month, with the result that intermediate variations are not always apparent. The intention has been to show the general trend of the weight development during several months of treatment rather than daily or weekly variations, which in out-patient cases are not available nor important.

As regards general symptoms, one may mention certain facts which are noticeable in all of the cases treated, irrespective of the weight development. Vomiting is generally quickly relieved, even when the percentage of fats is the same as in the cream mixtures. The stools in their gross appearance do not differ materially from those which are generally seen when maltose is a constituent of the food. Microscopically, the fat is generally split, fatty acids are rarely found in excess and soaps when present are not in abnormal amounts, though the quantity will vary in the same case, from time to time, without any change in the composition of the food. The frequency of the movements is not influenced by the percentage of olive oil so much as by that of the maltose.

The most striking change is the absence of toxic symptoms, and the vigorous appetite which the child develops. None of the cases has failed to take its full quota of food, and few have shown any discomfort, except from hunger.

In several cases, which have shown a tendency to foul movements, decided improvement has followed the use of bouillon cultures of Bulgarian lactic acid bacilli. These are a valuable adjunct to the food when putrid decomposition threatens to bring about a digestive crisis.

Of the cases I have put upon the homogenized olive oil mixtures at the hospital, there are three whose records I have not charted, for various reasons. One, Woodbury, No. 31316, discontinued her visits after six days, although the baby was gaining.

A second, Shaw, No. 31041, gained only 12 ounces in seven weeks, during which time she has had several operations on the neck for cervical glands with abscesses and for adenoids, and lately an attack of tonsillitis. The 12 ounces gained have all been in the last three weeks, in spite of the attack of tonsillitis and the operation for the removal of the adenoids.

A third case, Kennedy, No. 30944, has gained 10 ounces only in two months, or at the same rate as in the previous two months on ordinary

milk mixtures. This baby, however, now eight months old, shows a very strong von Pirquet reaction, is subject to attacks of bronchitis and laryngospasms, and is undoubtedly tubercular. In the last two weeks I have tried combining 2.5 per cent. of olive oil in a 1-8 dilution of condensed milk. On this mixture, the baby has gained 8 ounces in fourteen days. This is the only case in which I have used homogenized olive oil to make up the fat deficiency of condensed milk.

DUTCH.—(Private Ward C. H.) The case of Elizabeth Dutch is the most instructive of all those I have had under observation. She has been fed with homogenized olive oil for six months.

She was a 7½-pounds baby. For two months she was breast-fed and gained about 6 ounces. Substitute feeding was then tried for four months with a gain of 1 pound and 10 ounces only, various modifications with milk sugar, dextri-maltose and Mellin's Food being tried. A wet nurse was then introduced and in six and one-half months she gained 9 pounds and 2 ounces, with only one short, sharp illness caused by adding chicken broth and cereal to the breast-milk feeding. Her maximum weight at twelve and one-half months was 18 pounds 14 ounces.

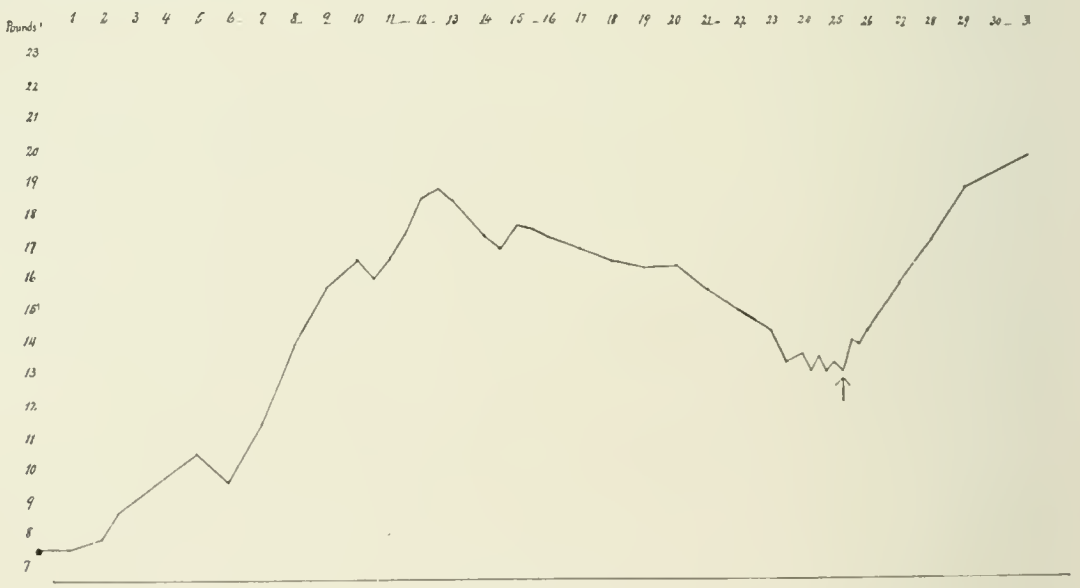

Figure 1

The second year was a history of irregular but progressive loss of weight to 13 pounds 3 ounces. During this time she was fed by experienced pediatrists and every effort made to adapt cow's milk and second-year diets to her digestion. The details of this feeding need not be gone into. The case presented the typical appearance and symptoms of fat intolerance with extreme malnutrition.

The homogenized olive oil malt soup feedings were begun when the child was two years and five weeks of age. In six months the child had gained from 13 pounds 3 ounces to 20 pounds, with corresponding improvement in general condition. In the last three months food of the second year has gradually been introduced and the child is now getting in addition to the olive oil, milk, cereals, broth, rice, macaroni, potato and zwieback.

The first olive oil formula was started at 1.00 olive oil, 5 maltose, 1.75 protein, 0.75 barley starch with bicarbonate of soda, which was later changed to lime water. This has gradually been increased to 2.75 olive oil, 6.00 maltose, 2.50 protein, 0.75 barley starch, 5.00 lime water. For a time the milk was heated to 212 F.

The stools showed for a short time free fat, fatty acids and soaps, but the gain in weight was rapid, and repeated later examinations have shown no free fat, fatty acids or soaps.

CHARLES OLSEN.—(No. 28753.) An eight-months baby weighing 4½ pounds at birth. At two months weighed 6 pounds 6 ounces and was breast-fed entirely until 5 months. From the fifth to the eighth month, the baby made no gain in weight, owing to acute otitis media and pertussis. The breast feeding was continued until the eighth month, when mixed feeding was started, owing to deficiency of the breast milk and failure to gain. From the eighth to the tenth month, the baby gained 3 pounds to 14 pounds 11 ounces, then at ten months the breast milk had dried up and was discontinued.

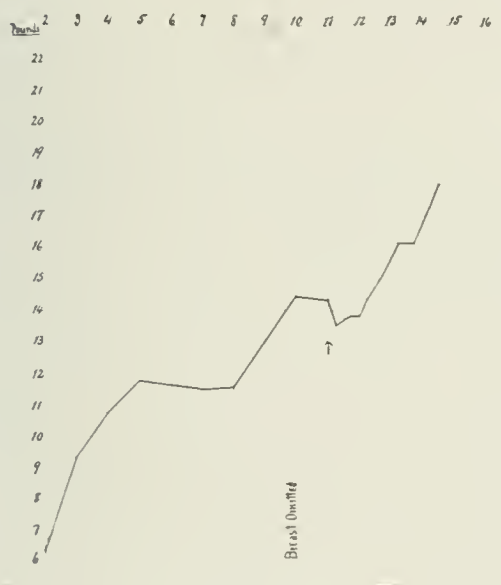

Figure 2

From the tenth to the eleventh month, on a modified milk of two-thirds whole milk and one-third barley water (3 per cent. starch) with dextri-maltose added, the child lost 2 ounces, grew pale, lost his appetite and had stools full of soaps. He appeared to be on the verge of a severe illness and was, in fact, so weak that I hesitated to experiment with mixtures containing fat of any sort, but as breast milk was not to be had I put him on January 26 on a homogenized olive oil mixture, of 1.50 olive oil, 5 maltose, 1.75 protein, 0.75 barley starch, 5 per cent. lime water, heated to 212 F.

For the first few days he continued to take his feedings poorly and in ten days lost 10 ounces, and the stools still showed a large excess of soaps. The olive oil was reduced to 1.00 per cent.

In the next week he gained rapidly in general condition, put on 3 ounces, stopped vomiting and developed a vigorous appetite. The soaps disappeared from the stools, which were of normal appearance, but slightly loose.

From February 6 to May 18, there has been a steady gain in weight, from 13 pounds 8 ounces to 18 pounds, a gain of 72 ounces in 101 days, about three-quarters ounce per day. In spirits and general condition the improvement has been even more striking. I have worked the formula up to 2.75 olive oil, 6.00 maltose, 1.75 protein, 0.75 barley starch, 10 per cent. lime water, heat to 212 F., 48 ounces in 24 hours. The last examination of the stools on May 18, shows no neutral fat nor fatty acids and a very slight amount of soaps.

This case was very typical of fat intolerance.

JOSEPH MADDOX.—(No. 30936.) Birth weight said to have been 10 pounds. Breast-fed one month, then weak home modifications for one month. Weight at first visit (two months) 6 pounds 5 ounces.

Figure 3

Fed in O. P. D. from January 15 to March 8, seven and one-half weeks with gain of 6 ounces, an average of less than one ounce a week. Last formula of this period was 2.50 fat, 6.25 lactose, 1.40 protein, 20 per cent. of milk and cream, lime water, seven feedings of 5 ounces. On this the stools showed no fat nor soaps, no vomiting, but a steady loss of weight for two weeks. Energy quotient had been increased from 132 to 173, without materially affecting the digestion or weight.

On March 8, the baby was put upon an homogenized olive oil mixture:

℞ 1.50 olive oil, 5.50 maltose, 1.00 protein, 0.75 barley starch, 5.00 lime water; heat 212 F.; eight feedings, 2½-hour intervals, 4 ounces each.

This gave an energy quotient of 127, which was practically the same as that prescribed on his first visit, but with the marked difference that in the first two weeks he gained 22 ounces.

On March 22 (weight 8 pounds 1 ounce), the olive oil was raised to 1.75 per cent. and the protein to 1.25.

On April 13 (weight 9 pounds 4 ounces), the formula was made: 2.00 olive oil, 6.00 maltose, 1.50 protein, 0.75 barley starch, 5.00 lime water; heat to 212 F.; 8 feedings of 4 ounces.

On May 4 (weight 9 pounds 9 ounces), the milk was changed to : 2.50 olive oil, 6.00 maltose, 1.75 protein, 0.75 barley starch, 10.00 lime water; heat to 212 F., seven feedings of 4¾ ounces.

On May 18, the stools were non-formed and showed no neutral fats, fatty acids nor soaps. The baby had gained to 10 pounds, making a total gain of 53 ounces in seventy days; compared with a gain of 6 ounces in fifty-two days, on the previous feeding.

ELEANOR KEOUGH. — (No. 30489.) Birth weight 11 pounds. Bottle fed from birth, starting with a high fat, with low sugar and protein. (4.00 fat, 1.9 sugar, 0.64 protein.) At the end of two months (time of entrance) her weight was 9 pounds 4 ounces. Stools contained free fat and soaps in excess. The symptoms were vomiting, scalding and loss of weight.

From the second to the sixth month the baby was fed in the O. P. D. as a case of fat indigestion. The vomiting was controlled, but the net gain in weight after four months of feeding was 8 ounces. The last formula used was 1.50 fat, 6 dextri-maltose, 1.00 protein, 10 per cent. of milk and cream, lime water, seven feedings of 6½ ounces.

On March 8, the baby was started upon the following homogenized olive oil mixture:

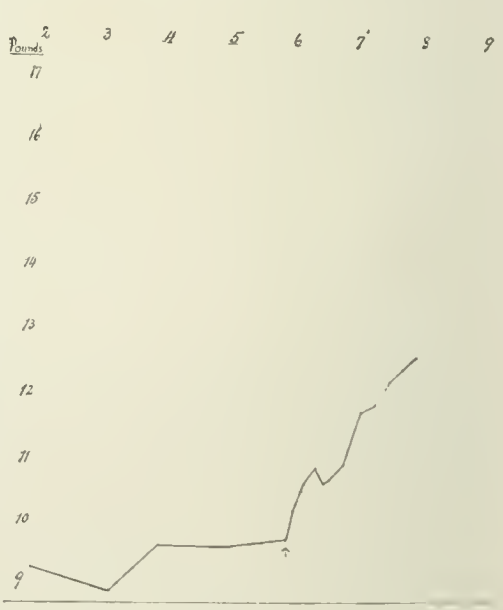

Figure 4

℞ 1.50 olive oil, 6.00 maltose, 1.00 protein, 0.75 barley starch, 5.00 lime water; heat 212 F.; feedings, three-hour intervals; 5½ ounces in amount.

In three days the baby gained 11 ounces, and fat and soaps disappeared from the stools, and in the following eleven days, 7 ounces.

On March 26, the baby's cold had developed into a hard paroxysmal, strangling cough with vomiting and ran the usual course of pertussis, but in spite of this handicap the gain in weight was continued.

On March 29, the food was increased to: 1.75 olive oil, 6.00 maltose, 1.50 protein, 0.75 barley starch, 10.00 lime water; heat 212 F; 32 ounces in twenty-four hours.

On May 11, the bowels being somewhat too loose from the maltose, but the baby showing signs of hunger, the milk was changed to: 2.50 olive oil, 5.00 maltose, 1.75 protein, 0.75 barley starch, 10.00 lime water; heat 212 F.; 40 ounces in twenty-four hours.

On May 18 the stools showed no neutral fat, fatty acids nor soaps. The weight was 13 pounds 5 ounces, or a gain of 53 ounces in seventy days, compared with a previous gain of 8 ounces in four months.

DOROTHY SULLIVAN.—(No. 30190.) Came to the O. P. D. on October 2, 1914, when 2 months old. Birth weight 7 pounds; present weight 6 pounds 14 ounces. She had been exclusively breast-fed for one month, then was put on cow's milk and water, Imperial Granum, malted milk, etc.

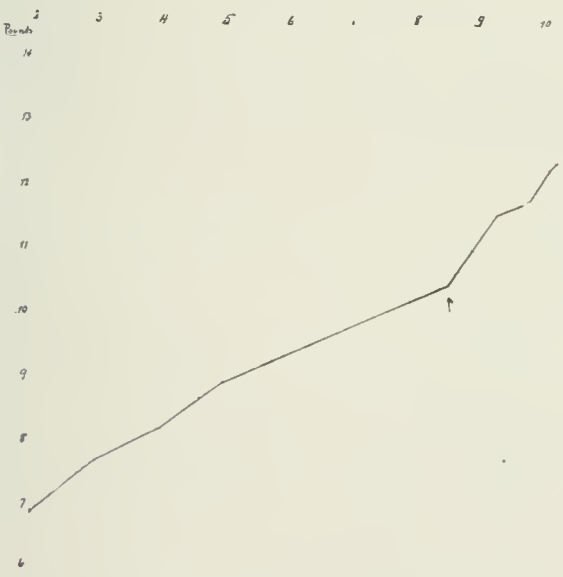

Figure 5

From October 2 to April 14, for six and one-half months, she was fed on a variety of formula, most of them malt mixtures with low fats or fats not exceeding 2 per cent., on which she showed undigested fat. She gained in this time 57 ounces, or an average of about 2 ounces a week, and on April 14 showed signs of early scorbutus. Her weight was then 10 pounds 7 ounces, her age 8½ months.

She was given orange juice and put on an homogenized olive oil mixture of: 1.50 olive oil, 5.00 maltose, 1.50 protein, 10.00 lime water, 0.75 barley starch; 42 ounces in twenty-four hours.

From April 14 to May 18, she has gained to 12 pounds 6 ounces, or 31 ounces, an average of 6 ounces a week, compared with 2 ounces a week during the previous six and one-half months. The olive oil mixture was changed on May 4 to: 2.00 olive oil, 5.50 maltose, 1.75 protein, 10.00 lime water, 0.75 barley starch; 45 ounces in twenty-four hours.

This she is digesting normally. The signs of scorbutus disappeared after a few days of orange juice.

EILEEN CLARKE.—Twenty-five months old, was admitted to the wards on January 23. Her birth weight was 9 to 10 pounds. She was breast-fed for eight months, then fed on barley water, milk, bread and beef-juice. She was admitted with a history of swelling of the feet and abdomen, vomiting, loss of weight. The weight in the O. P. D. was recorded as 23 pounds, but her first weight in the wards four days after entrance was 18 pounds 8 ounces. In the following nine days she lost to 17 pounds 8 ounces on a low fat, low starch diet without milk. The provisional diagnosis was tubercular peritonitis, but the von Pirquet reaction was negative. There was a fluid wave, and shifting dulness, but no tenderness nor palpable glands nor abdominal tumors.

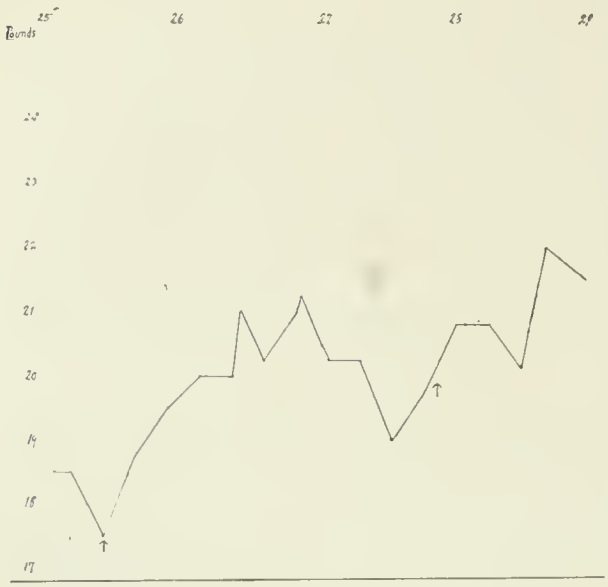

Figure 6

The stools showed a large excess of starch, great excess of soaps and fatty acids and some neutral fat.

On February 1, the day before her low point of 17½ pounds was reached, the child was started upon an homogenized olive oil milk; *i. e.:* 1.50 olive oil, 5.00 maltose, 1.75 protein, 0.75 barley starch, 5.00 lime water; 48 ounces in twenty-four hours.

Two days later 2 tablespoonfuls of barley jelly were given and the milk increased to 54 ounces. For three weeks there was a steady and striking improvement in the child's condition. The appetite improved, edema disappeared, the disposition improved, and the child had gained 2 pounds.

The olive oil was then raised (on February 20) to 2 per cent., barley jelly increased and zwieback given, the calories taken at that being 1,005. No gain in weight followed and an attempt to increase the amount of food by adding more maltose (0.50 per cent.), and more protein (0.50 per cent.) with broth and rice, resulted in a sharp gain of 1 pound in two days, with nearly as rapid a loss during the next five days.

The history during the next six weeks was unfavorable. The food was changed along the line of reducing the amount of olive oil to as low at 1.00 per cent. In three weeks the child lost irregularly from 21 pounds 4 ounces to 18 pounds and 14 ounces, and then in two weeks with as little reason went back to 20 pounds and 4 ounces.

Many examinations of the stools were made. At first there was much neutral fat, soaps and fatty acids; at the end of the first three weeks the baby was digesting its fat, and stools showed only a slight amount of neutral fat, no fat nor soaps (February 22), but the increase of fat a few days later was followed by fat stools, soaps and fatty acids, which greatly diminished with the reduction of olive oil to 1.00.

The extreme variation in weight in the last six weeks was coincident with marked development of enlarged inguinal lymph nodes, and variable abdominal distention, though no abdominal masses were felt under ether.

As the case seemed to me to be developing symptoms strongly suggestive of tabes mesenterica, in which I felt that any kind of fat was contraindicated, I discontinued the olive oil milk. The child was put on a fat-free modified milk with cereal, zwieback, bread, one-half egg and potato (calories 1,316). On this, the stools showed only a slight excess of neutral fat and no soaps or fatty acids. The child gained 4 ounces in a week, was sent home, and returned to the O. P. D. a week later having lost 10 ounces. In the next week it gained 1 pound 14 ounces, and in the following week lost 8 ounces.

At present the child's abdomen is greatly distended, tense, impossible to palpate and dull in the flanks. If the case eventually proves to be tubercular peritonitis, the explanation of the irregular course of symptoms is easy. If it proves not to be, I must admit that the olive oil mixture in this case of obvious fat indigestion was of no permanent benefit.

WATSON.—*House Records.*—Was admitted to the throat department when 15 months old, weighing 14½ pounds. Birth weight 7 pounds 2 ounces. Gave a history of difficult feeding with vomiting and a failure to gain normally. Roentgen rays showed a dilatation of the esophagus at the junction of the lower and middle thirds. The child was esophagoscoped and a stricture found at this point. There was a family history of syphilis, and the Wassermann reaction on the child was positive. For four months the baby had been dilated under ether at frequent intervals by Dr. Greene. In the first week there was a sharp loss of 1 pound in weight. Since then, there has been a gradual gain, interrupted generally by sharp losses at the time of each operation. At the end of four weeks the baby showed a loss of 4 ounces over her entrance weight, and she was at that time put upon a homogenized olive oil milk, beginning with 1.50 olive oil, 5.00 maltose, 1.75 protein, 0.75 barley starch, 48 ounces in 24 hours, and increasing in strength to 3.00 olive oil, 6.50 maltose, 1.75 protein, 0.75 barley starch. Frequent examinations of the stools have shown the fat well assimilated, no neutral fat, rarely a small amount of fatty acids, but generally none, and either no soaps or a very small amount. The improvement in the baby's appetite and general condition cannot, of course, be attributed to any special virtue of the olive oil mixture in this case, as an equal gain might have taken place on any kind of feeding due to the dilatations of the stricture.

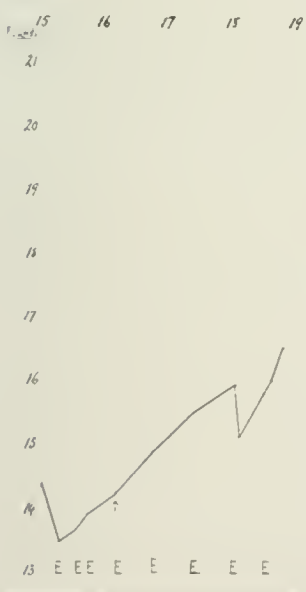

Figure 7

BARRY.—(No. 30237.) Was brought to the clinic when 7 weeks old, weighing 6 pounds 9 ounces. Child was breast-fed, constipated and gaining slowly. She was admitted to the Infants' Hospital and gained 2 pounds in two months, and when discharged was getting 2.00 fat, 5.00 dextrimaltose, 1.00 protein, 0.75 barley starch. This proved too strong and the baby developed gastric and

intestinal indigestion, with some free fat and excess of soaps in the stools. Reduction of the fats and sugar relieved the indigestion, but the rate of gain was slow. In 5½ months of treatment, there was an average gain of 0.45 ounce daily.

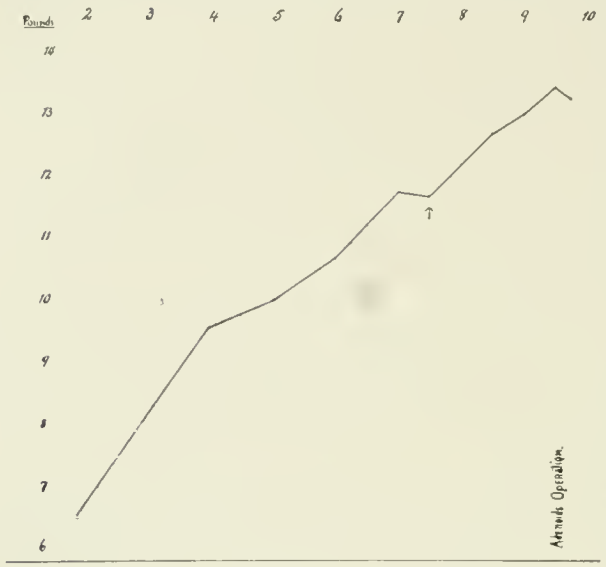

Figure 8

On March 20, the baby was started upon an homogenized olive oil mixture, 1.50 olive oil, 4.00 maltose, 1.50 protein, 1.00 barley starch, 42 ounces in twenty-four hours.

On March 31, the olive oil was raised to 2.00 per cent., the maltose to 5.00 per cent. and the mixture boiled.

On May 1, the olive oil was increased to 2.50 per cent., and on May 11 to 2.75 per cent. In fifty-nine days of treatment on olive oil mixture, there has been a gain of 0.4 ounce per day, practically the same as on the previous feeding. The baby has been developing marked obstruction from adenoids, which were removed on May 14, following which there was a loss of 4 ounces. The last examination of the stools on May 18 showed no neutral fat, fatty acids, nor soaps.

This case shows only that olive oil was as efficient as cow's fat, but no more so. In neither case has the feeding been more than fairly successful, which may be found to have been caused by the excessive growth of adenoids.

MARGARET NICHOLS.—(No. 30563.) Was admitted to the O. P. D. when 4½ months old, weighing 7 pounds 10 ounces. Was then on a 3-6-1 mixture and the stools were "loaded with soaps." She was treated for 3½ months on low fat mixtures, not exceeding 2 per cent., dextrimaltose 4.50 to 5.50 and proteins 1.50 to 2.00. She gained 2 pounds 4 ounces during this period, or about 0.4 ounce a day.

Figure 9

On February 24, she was put upon an homogenized olive oil mixture of: 2.00 olive oil, 5.00 maltose, 1.40 protein, 0.75 barley starch, 20 per cent. of milk and cream, lime water; 42 ounces in twenty-four hours.

The stools showed no fat or soaps at this time, but they became loose, and the maltose was changed to dextrimaltose. On May 4, the olive oil was raised to 2.50 per cent.

Shortly after starting this feeding the child developed measles, and yet in spite of this complication gained 27 ounces in sixty-four days, or about one-half ounce a day. The improvement in this case so far is only fair, but is at exactly the same rate as on the previous feedings. The last examination of the stools on May 18 showed no neutral fat nor fatty acids, but a slight amount of soaps.

In general, the results obtained in the use of homogenized olive oil as a substitute for cow's fat in cases of difficult feeding are such as to warrant the hope that it will prove a safe and valuable means of administering fat in the so-called cases of "fat intolerance." Its use will not, however, relieve the physician of the necessity of intelligent application of the principles of modification and adaptation of the food to the individual requirements of the infant.

270 Clarendon Street, Boston.

DISCUSSION

ON THE PAPERS OF DRS. GERSTENBERGER, HASKINS, M'GREGOR AND RUH, AND DR. LADD

DR. COIT: I should like to ask Dr. Gerstenberger whether he is able to tell us how the caloric value of this mixture compares with human milk?

DR. GERSTENBERGER: The caloric value of our milk is about 770. We determined the value of the milk in the calorimeter in order to get a check on the quantitative analysis of the fat content. We had been putting in an amount of fat which we thought ought to raise the fat content to 4.5 per cent., but by analysis found that it contained but 3.5 per cent. fat. This finding was corroborated by the calorimetric determination, which gave us a calorimetric value of 669 per liter for the food with 3.5 per cent., and 760 calories per liter for the food with 4.5. In adding enough fat to make the total 4.5 per cent. we were simply carrying out Friedenthal's directions, as stated by Bahrdt. It is not our intention to continue to give the milk such a high per cent. of fat.

DR. HOOBLER: There has been some work done recently in connection with this matter of mixed foods, by McCollom and Davis, as reported in the April, 1915, number of the *Journal of Biological Chemistry*. They have shown that there are two types of fats: those that are the product of glandular tissue, and those that are not. Cocoanut oil, cottonseed oil, tallow, etc., belong to the latter type. These authors have carried out some careful feeding experiments, and have found that animals are not sufficiently or properly nourished on nonglandular fats; but that when glandular fats are added to their diet, perfect nutrition takes place. Their point is that there may be increase in weight with a diet containing nonglandular fats, but not true nutrition. They require further evidence of true nutrition than mere increase in weight. They base their requirements on the ability of the individual so nourished to produce normal offspring. They have shown that animals fed on these nonglandular fats are unable to produce normal offspring. With this knowledge at hand, we should at least inquire definitely whether foods such as have been suggested here are clearly fulfilling, in every degree, the standard of nourishment which we wish the children to secure.

DR. GERSTENBERGER: I should like to add that, of course, we realized in making our mixture of fat and cocoanut oil that we might not, in view of the work carried out by Osborne and Mendel, get a gain in weight. As you know, Osborne and Mendel found in their work with rats that lard was not compatible with growth, and that at a time when the animal's weight was stationary on the lard diet it would increase in a normal fashion if the lard was replaced with other fats, especially with butter and codliver oil. Peiser has reported clinical observations in the substitution of various fats in a food mixture that in other respects remained unchanged. He used as his basic food the prepared buttermilk, the so-called *Hollandesche Säuglingsernährung,* and added to this different fats—butter, cream, codliver oil, sweet almond oil, sesame oil, and others—but found that the children gained with any of the fats, but that there was a difference in the results obtained by the individual fats. As you will remember, Osborne and Mendel in their work with rats got negative results with sweet almond oil. It is possible that the positive results obtained by Peiser with sweet almond oil were due to the butter fat content of the buttermilk, which amounts to about 0.5 per cent.

The babies that have been taking our milk have not vomited, except for a slight spitting up, have had good stools, and have gained in weight. The time is too short to speak further about them.

THE TOTAL NONPROTEIN NITROGEN AND THE UREA OF THE BLOOD, AND THE PHENOLSULPHONEPHTHALEIN EXCRETION IN CHILDREN *

WILDER TILESTON, M.D., AND C. W. COMFORT, M.D.
NEW HAVEN, CONN.

The total nonprotein nitrogen of the blood has not been studied in children, so far as we are aware, and the urea of the blood has been determined only by the somewhat crude hypobromite method, to which, as Rowntree and Fitz[1] have shown, an error of from 10 to 60 per cent. attaches. We have therefore thought it worth while to investigate the blood in this respect, in various diseases of childhood and in healthy children. We have also investigated the phenolsulphonephthalein excretion, using the method of Rowntree and Geraghty. Owing to the small material available, the series is far from complete.

The term "nonprotein nitrogen" is synonymous with incoagulable nitrogen, rest or waste nitrogen and retention nitrogen, and designates the nitrogen of those substances remaining after the removal of the proteins. It includes the urea, creatinin, amino-acids, uric acid, and ammonia of the blood.

Technic.—For the nonprotein nitrogen and the urea nitrogen the methods of Folin and Denis[2] have been followed. Only a small amount of blood, from 2 to 5 c.c., is required. The blood was drawn from a vein of the arm or from the external jugular vein by means of a syringe. Whole blood was used, clotting being prevented by means of potassium oxalate. The figures are calculated in terms of milligrams of nitrogen per hundred cubic centimeters of blood. The values obtained for urea nitrogen include the ammonia nitrogen, which, however, is so small in amount in normal blood, and presumably in most cases of disease, as to be negligible.

In performing the phenolsulphonephthalein test, or as it will be called henceforth, for short, the phthalein test, the directions of Rown-

* From the Department of Medicine, Yale University Medical School.

1. Rowntree, L. G., and Fitz, R.: Arch. Int. Med., 1913, xi, 258.
2. Folin, O., and Denis, W.: Jour. Biol. Chem., 1912, xi, 527.

tree and Geraghty[3] were followed. The urine was obtained by catheter in every instance, the catheter being held in place by strips of adhesive plaster. This is necessary in the case of young children who will not urinate on command, and for the sake of uniformity of results, was done also in the case of the older children. The urine was collected separately for each of the first two hours after the injection, and the amount of the dyestuff was estimated in each of the two specimens.

The nitrogen and the urea determinations were made by Tileston, the phthalein estimations by Comfort.

Total Nonprotein Nitrogen and Urea Nitrogen in Healthy Children.—At first we took the blood in the morning, just before the noon meal, an arrangement which has proved satisfactory in the case of healthy adults, who show at this time from 22 to 26 mg. nonprotein nitrogen, about half of which is in the form of urea nitrogen.

We found in children, however, as will be seen by glancing at Table 1, a considerable variation at this time of day, in one case up to 34 mg. of nitrogen. We were led, therefore, in the case of children over 2 years of age, to take the blood before breakfast after a fast of twelve hours or more. In the two cases examined at this time there were 24.4 and 26 mg. of nitrogen and 9.5 and 10.9 mg. of urea nitrogen, respectively. The urea is seen to form somewhat less than one-half of the total nonprotein nitrogen, while if the influence of diet is not eliminated, the urea may constitute considerably more than one-half the total.

The influence of diet must therefore always be borne in mind in this kind of work, though in the case of children who are acutely sick, and taking in consequence less than the accustomed amount of food, we have found that the blood may be taken at any time of day without the liability of error.

The Phenolsulphonephthalein Excretion in Healthy Children.—The phthalein excretion in normal children has been found to vary from 35 per cent. to 64 per cent. for the first hour, and from 17 per cent. to 44 per cent. for the second hour. These wide variations are eliminated, however, if the total excretion for the two hours be considered, the figures then falling within very narrow limits, from 78 to 81 per cent. It is therefore evident that no conclusions can be safely drawn

3. Rowntree and Geraghty: Jour. Pharm. and Exper. Therap., 1909, i, 579.

from this test unless the period of observation is extended to two hours. For practical purposes it will be sufficient to collect the urine for two hours in one vessel and make one determination of the phthalein.

The phthalein excretion in healthy children is considerably higher than in the adult, where values anywhere from 50 to 80 per cent. are considered normal.

A word of explanation is necessary in connection with the urine examinations in Table 1. The presence of red cells and a slightest possible trace of albumin is accounted for in some instances by the fact that a catheter has been passed previously. In other cases it is the normal albuminuria which can usually be demonstrated in health by the nitric acid test, if done by an expert.

Acute Nephritis.—Owing to the small size of the clinical material, we have but three cases of nephritis to report, all acute. The first was a case of scarlatinal nephritis in a girl 8 years old. The history was vague, fever having been remarked a week before entrance to the hospital, and swelling of the feet five days later, but no rash. The diagnosis was cleared up later by the appearance of typical desquamation of the feet. Mild uremic symptoms were present, such as prostration, drowsiness and vomiting. The eyelids were puffy, but there was no edema elsewhere. The examination of the urine indicated an acute nephritis of considerable severity, showing 0.3 per cent. albumin, with many brown granular and hyaline casts, red blood corpuscles and leukocytes. Both the nitrogen and the urea were markedly increased, the former measuring 64 and the latter 43 mg. The phthalein excretion was 39 per cent. in two hours. A month later the nitrogen had fallen to normal and the albumin to a very slight trace, and she was discharged well soon afterward.

The second case was one of unknown origin and moderate severity, in a boy 9 years old. The only symptoms were puffiness of the face and albuminuria. The urine showed a large trace of albumin, with many blood and granular casts, red blood cells and leukocytes. There was a slight elevation of the blood nitrogen (34.5 mg.) and of the urea (21 mg.). The phthalein output was 56 per cent. in two hours. The albumin dropped in a few days to a slight trace, the casts and red cells being still numerous. He was discharged at the end of two weeks with only the slightest possible trace of albumin and a few casts.

TABLE 1.—Normal Cases *

Name	Case No.	Sex	Age	Diagnosis	Phenolphthalein			Urine			Diet	Blood		Remarks
					Per Cent. in 1st Hr.	Per Cent. in 2d Hr.	Total in 2 Hrs.	Sp. Gr.	Alb.	Microscopical		Total N, Mg.	Urea N, Mg.	
Leissenhaltz..	1	M	7	Fractured leg.....	64	17	81	1.031	S. P. T.	Many W. B. C. and R. B. C.	Mixed...	20.2	10.5	Blood taken at noon.
Juliano.....	2	M	9	Fractured arm....	58	20	78	1.020	S. P. T.	Negative.....	Mixed...	24.4	9.5	Blood taken fasting.
Ferraro.....	3	M	4½	Fractured femur..	35	44	79	1.025	S. P. T.	Negative.....	Mixed...	26.0	10.9	Blood taken fasting.
Melillo.....	4	M	3	Burn of eye.....	52	27	79	1.030	S. P. T.	W. B. C.	Mixed...	31.9	17.8	Blood taken at noon.
Dest.	5	M	3	Phimosis.....	..	..	..	1.018	0	Negative.....	Mixed...	34.0	19.6	Blood taken at noon.

* The following abbreviations are employed in this and following tables: S.P.T. = slightest possible trace; V.S.T. = very slight trace; S.T. = slight trace; H.T. = heavy trace; W.B.C. = white blood corpus cles; R.B.C. = red blood corpuscles; the figures for albumin were obtained by the Esbach method, and represent percentages.

TABLE 2.—NEPHRITIS

Name	Case No.	Sex	Age	Diagnosis	Day of Disease	Phenolphthalein			Urine			Diet	Blood		Remarks
						Per Cent. in 1st Hr.	Per Cent. in 2d Hr.	Total in 2 Hrs.	Sp. Gr.	Alb.	Microscopical		Total N, Mg.	Urea N, Mg.	
Faust.....	6	M	2½	Ccute nephritis, complicating acute lobar pneumonia	9	40	14+	54+	1.026	H. T.	Hyaline, granular, and epithelial casts; many R. B. C.; W. B. C.	Liquid..	26.2	13.6*	T. = 99.7 F.
									1.027	S. P. T.	Rare hyaline cast; occasional W. B. C.	.....	....	....	Five days later.
Lucibello....	7	M	9	Acute nephritis...	11	19	37	56	1.015	H. T.	Many blood and granular casts; many R.B.C. and W.B.C.	Low protein	34.5	21.0	T. = 99 F. Etiology unknown
Dunn.....	8	F	8	Acute nephritis, complicating scarlatina	4-9	..	..	39	1.010	0.3 %	Hyaline and brown granular casts; many R.B.C. and W.B.C.	Liquid..	63.6	42.9	T. = 98.6 F.
									1.013	V. S. T.	Hyaline, granular, and pus casts; R.B.C.: W.B.C.	Liquid..	31.0	....	T. = 98.6 F. thirty days later.

* One determination.

TABLE 3.—PNEUMONIA

Name	Case No.	Sex	Age	Diagnosis	Day of Disease	Phenolphthalein			Urine			Diet	Blood		Remarks
						Per Cent. in 1st Hr.	Per Cent. in 2d Hr.	Total in 2 Hrs.	Sp. Gr.	Alb.	Microscopical		Total N, Mg.	Urea N, Mg.	
Carbone....	9	F	4	Pneumonia, acute lobar	6	5	40	45	1.024	V. S. T.	Very many W.B.C.....	Soft.....	20.2	13.3	Temp. 105.4 F.
Katz.....	10	M	15mo.	Pneumonia, acute lobar	9	5	12	17		S. P. T.	Granular casts; W.B.C.	Formula	22.2	12.9*	Temp. 104 F.
Szeresnowicz	11	M	9	Pneumonia, acute lobar	5	..	..	68	1.024	S. P. T.	W.B.C.	Soft.....	23.1	11.8	Temp. 104.2 F. Crisis ended next day. Moderately severe case
													24.0	12.6*	Temp. 98.6 F.
Grauel.....	12	F	8	Pneumonia, acute lobar	..	..	..	63	1.020	V. S. T.	Occasional hyaline cast and R.B.C.; W.B.C.	Very soft	24.4	13.8	Temp. 100 F.
Rumano....	13	M	9	Pneumonia, acute lobar	11	55	30	85	1.025	S. P. T.	Occasional R.B.C.: few W.B.C.	Soft.....	24.7	10.4	Temp. 102 F.
Knudsen....	14	F	8 mo.	Pneumonia, acute lobar	8	..	..	53		S. P. T.	Rare hyaline and granular casts; few R. and W.B.C.	Formula	25.6	11.7	Temp. 102 F. Empyema later.
Malvedo...	15	M	3 mo.	Pneumonia, acute lobar	8	..	..	..		S. P. T.	Negative.....	Formula	28.3	14.6	Temp. 105 F. Died next day.
Levy.....	16	M	5	Pneumonia, acute lobar	3	..	..	70	1.020	S. P. T.	Rare hyaline cast; numerous W.B.C.	Soft.....	29.7	21.2	2/22/15. Temp. 104 F.
													27.8	15.2*	2/24/15. Temp. 99 F.
Zoufman....	17	M	8	Pneumonia, acute lobar	7	..	..	57	1.025	S. P. T.	Occasional fine granular and hyaline cast and R.B.C.; W.B.C.	Soft.....	32.6	19.8	Temp. 103 F.

TABLE 4.—Scarlatina and Typhoid Fever

Name	Case No.	Sex	Age	Diagnosis	Day of Disease	Phenolphthalein			Urine			Diet	Blood		Remarks
						Per Cent. in 1st Hr.	Per Cent. in 2d Hr.	Total in 2 Hrs.	Sp. Gr.	Alb.	Microscopical		Total N, Mg.	Urea N, Mg.	
Russell.....	18	M	7	Scarlatina.....	5 da.	..	..	..	1.028	0	Negative..... ..	Soft.....	21.7	10.1	Temp. 103.5 F. Moderately severe case.
Vaughn.....	19	F	10	Scarlatina.....	4 da.	..	..	..	1.018	S. P. T.	Negative.....	Soft.....	23.2	10.9	Temp. 100.8 F. Moderately severe case.
Miller.....	20	M	11	Scarlatina.....	3 da.	42	40	82	1 029	S. P. T.	W.B.C.	Liquid..	26.6	15.3	Temp. 99 F. Blood taken fasting. Mild case.
Dowd.....	21	F	7	Scarlatina.....	5 da.	..	..	74	1.032	V. S. T.	Few hyaline and granular casts, W.B.C.	Liquid..	26.7	15.1	Temp. 100.8 F. Mild case.
Koskoff, Y.	22	M	9	Scarlatina.....	3 da.	26	46	72	1.027	S P T.	W.B.C.	Liquid..	26.9	16.3	Temp. 102.8 F. Blood taken fasting. Moderately severe case.
Scandone...	23	F	17mo.	Scarlatina.....	5 da.	44	5 +	49 +		S. P. T.	W.B.C.	Liquid..	27.8	13.6*	Temp. 101 F. Mild case.
Cohen.....	24	F	3	Scarlatina.....	3 da.	40	34	71	1.024	S. P. T.	Fine granular casts; rare R.B.C.; W.B.C.	Soft.....	28.1	14.2*	Temp. 102.5 F. Moderately severe case.
Koskoff, L.	25	F	5	Scarlatina.....	1 da.	35	29	64	1.018	0	Negative.....	Liquid..	28.5	15.4	Temp. 101 F. Blood taken fasting. Mild case.
Weinstein...	26	F	7	Scarlatina.....	2 da.	55	31	86	1.032	0	Negative.....	Soft.....	29.1	13.8	Temp. 101 F. Moderately severe case.
Bartholemew	27	M	10	Scarlatina.....	5 da.	..	..	66	1.030	S. P. T.	Negative.....	Soft.....	31.9	....	Temp. 99 F. Mild case.
Gentile.....	28	M	3	Typhoid fever....	10 da.	31	32	63	g.n.s.	S. P. T.	W.B.C.	Typhoid	21.9	10.3	Temp.101-104F. Blood taken fasting.
Daniels.....	29	F	8	Typhoid fever....	10 da.	48	24	72	1.026	S. P. T.	Few W.B.C.	Typhoid	22.7	11.1	Temp. 104 F. Blood taken fasting.
Wilens.....	30	M	8	Typhoid fever....	7 da.?	..	..	75	1.010	V. S. T.	W.B.C.	Typhoid	22.7	11.9	Temp. 104 F.
Cruscola....	31	F	5	Typhoid fever....	5 wk.	56	8	64	1.012	S. P. T.	Occasional granular cast; few R. and W.B.C.	Typhoid	25.0*	....	Temp. 102 F.
Daddio.....	32	M	5	Typhoid fever....	8 da.	24 +	36 +	57 +	1.028	S. T.	Occasional fine granular cast; R.B.C.	Typhoid	29.0	14.2	Temp. 99-102 F.
Gladwin.....	33	F	10	Typhoid fever....	12 da.	..	..	71	1.020	V. S. T.	Hyaline casts; few R.B.C.; W.B.C.	Typhoid	29.2	15.8	Temp. 103 F.

* One determination.

TABLE 5.—Miscellaneous Diseases

Name	Case No.	Sex	Age	Diagnosis	Day of Disease	Phenolphthalein			Urine			Diet	Blood		Remarks
						Per Cent. in 1st Hr.	Per Cent. in 2d Hr.	Total in 2 Hrs.	Sp. Gr.	Alb.	Microscopical		Total N, Mg.	Urea N, Mg.	
Brazen.....	34	M	3½	Diphtheria.....	1 da.	..	..	..	1.020	0	Negative.....	Liquid..	25.3	13.9	Temp. 102.8 F. Mild case.
Peck.....	35	M	8	Diphtheria.....	3 da.	61	15	76	1.020	S. P. T.	Few hyaline casts and W.B.C.; rare R.B.C.	Liquid..	28.4	14.1	Temp 99 F. Severe case. Complicated later by myocarditis.
Sinclair.....	36	F	8	Pertussis.....	3 wk.	24	6	30	1.026	0	Occasional W.B.C.	Liquid..	23.6	11.0	Temp. 102.4 F. Complicated by bronchopneumonia.
Campagne..	37	F	6	Tuberculous neck glands	3 mo.	51	19	70	1.026	S. P. T.	Few W.B.C.	Mixed...	24.4	....	Temp. 99 F. Blood taken fasting.
Frabianna..	38	F	3	Tuberculous peritonitis	6 wk.	..	..	63		S. P. T.	Few granular casts and R.B.C.; many W.B.C.	Soft.....	27.2	12.0	Temp. 98-102 F.
Daniels.....	39	F	8	Tuberculous hip..	1 yr.	..	..	84	1.022	S. P. T.	Rare R.B.C.; W.B.C...	Soft.....	27.2	....	Temp. 98.6 F.
Ryan.....	40	M	5	Tuberculous hip and spine	..	38	45	83	1.032	0	Negative.....	Soft.....	32.0	17.3	Blood taken fasting.
Masorka....	41	F	13mo.	Tuberculous meningitis	2 wk.	..	..	..	.....	.....	.....	Formula	21.2	10.3	
Makarias...	42	F	18mo.	Tuberculous meningitis	1 wk.	56	23	79		S. P. T.	Many R. and W.B.C...	.....	27.5	14.2	Temp. 102 F.
Alberino....	43	F	10	Tuberculous meningitis	5 da.	..	..	55	1.032	V. S. T.	Rare hyaline cast; W.B.C.	Liquid..	31.6	19.1	Temp. 102.8 F.
Villow.....	44	M	4	Cerebrospinal meningitis	4 da.	63	15	78	1.015	V. S. T.	Rew granular casts; R. and W.B.C.	Soft.....	25.9	11.4	Temp. 101.8 F.
Hathaway..	45	F	7	Keratitis; congenital lues	8 wk.	..	..	61	1.022	S. T.	Few W.B.C.	Mixed...	23.4	13.6	Temp. 99 F.
Lavalle.....	46	M	8	Endocarditis and pericarditis, rheumatic	..	..	..	80	1.022	S. P. T.	Few hyaline casts; W B C	Soft.....	22.7	11.0	Temp. 102 F.
Weiss.....	47	F	6½	Chorea.....	2 wk.	..	..	..	1.025	0	Negative.....	Low protein	23.6	12.1	Temp. 99 F. Blood taken fasting.
Mazzanotti.	48	M	6	Rickets.....	..	63	15	78	1.023	S. P. T.	Few W.B.C.	Soft.....	23.4	10.6	Blood taken fasting.
Rascati.....	49	M	2½	Rickets, gastroenteritis	2 mo.	43	29	72	1.016	S. P. T.	W.B.C.	Soft with extras	26.9	12.7	Temp. 102 F. Blood taken fasting.
DiYilsi.....	50	F	4	Rickets.....	..	..	..	86	1.018	0	Negative.....	Mixed...	29.7	18.1*	Temp. 99.2 F.
Ferrucci.....	51	F	8	Ichthyosis.....	8 yr.	..	..	74	1.015	S. P. T.	Many R. and W.B.C...	Mixed...	21.5	11.7	Temp. 98 F.

* One determination.

The third case occurred as a complication of lobar pneumonia, in a boy 30 months old. He entered the hospital on the eighth day of the disease, the crisis occurring next day. There was a large trace of albumin in the urine, with hyaline, granular and epithelial casts, and red blood cells. The blood nitrogen and urea were normal and the phthalein excretion over 54 per cent. (some urine lost). Five days later the albuminuria had nearly disappeared and he was discharged well soon after. This case might be regarded as one of febrile albuminuria by some, on account of its prompt subsidence, but the large amount of albumin, together with the frequency of nephritic changes (especially glomerulonephritis) at postmortem examinations of such cases, would appear to justify the diagnosis.

The cases, so far as they go, indicate that nephritis when accompanied by uremic symptoms tends to show a marked increase in the total nitrogen and urea. In the cases without uremic manifestations, on the other hand, the increase is slight or absent. The phthalein appears to vary roughly with the degree of impairment of renal function.

Acute Lobar Pneumonia.—In this disease nine out of ten patients showed no increase whatever in the total nitrogen; in the tenth case there was a trifling increase up to 33 mg. The urea was normal in eight cases, and moderately increased in two. This is contrary to our experience[4] in the pneumonia of adults, where 70 per cent. of those over 21 years of age showed more than 35 mg. of nitrogen. A fatal case in an infant of six months showed normal figures for both nitrogen and urea the day before death, as did also the case complicated with nephritis, already alluded to in the section on nephritis.

The phthalein excretion in pneumonia varied from 17 to 85 per cent. for two hours, the average being 57 per cent. The case with 17 per cent. excretion showed only a slightest possible trace of albumin and 22 mg. of nitrogen, not differing either clinically or with respect to the blood and urinary findings from the case with 85 per cent. excretion. The child with nephritis showed over 54 per cent. phthalein. These facts illustrate the danger of drawing conclusions from a single application of the phthalein test in acute conditions.

Scarlatina.—We were particularly interested in this disease, on account of the frequency with which nephritis occurs as a complication. Contrary to our expectations, we found practically normal values

4. Tileston and Comfort: Arch. Int. Med., 1914, xiv, 620.

in all of the ten cases not complicated by nephritis, the highest figure for nitrogen being 32 mg. and the highest for urea 16 mg. The case of scarlatinal nephritis has been described already, in the section on nephritis.

The phthalein excretion in the cases without nephritis averaged 75 per cent., a much higher figure than that obtained in pneumonia (57 per cent.).

Typhoid Fever.—Six cases of typhoid fever all showed normal values for both nitrogen and urea. The phthalein excretion averaged 68 per cent.

We have also examined instances of diphtheria, pertussis with bronchopneumonia, tuberculosis of various tissues, cerebrospinal meningitis, hereditary syphilis, rheumatic pericarditis, chorea, rickets and ichthyosis; all with negative results.

CONCLUSIONS

1. The determination of the total nonprotein nitrogen and urea of the blood is of great assistance in the diagnosis of uremia, and as a guide to the treatment of nephritis, a marked increase in these substances indicating actual or impending uremia, and calling for a diet low in protein. In the diagnosis of nephritis it is inferior to other methods, because many cases of nephritis show no retention of nitrogen.

2. The phthalein test is very valuable in the diagnosis of nephritis, showing probably better than any one other method the degree of impairment of renal function. In the diagnosis of uremia and as a guide to diet it is inferior to blood analysis, for a low phthalein output may occur without retention of nitrogen.

3. These investigations of the blood and of the phthalein excretion would appear to indicate a better secreting capacity of the child's kidney as compared with that of the adult.

DISCUSSION

DR. MORSE: Dr. Hill has just started some work at the Children's Hospital on the phthalein excretion, and also on the blood nitrogen and salt excretion, in children, in health and with nephritis. We have not got very far, but have obtained the same results as Dr. Tileston; that is, that the phthalein excretion is higher in health in children than in adults. We have also found, in a number of cases of nephritis, very little interference with the phthalein excretion. It is probable, therefore, that the determination of the phthalein excretion will not be of as much use for prognosis in nephritis in children as in adults.

DR. FREEMAN: We have had a series of phthalein experiments made, in some of which the children passed as much as 90 per cent. in two hours. One child with severe nephritis passed only 3 per cent. in two hours. He has practically recovered although he still has albumin in his urine. Such a recovery would scarcely occur in an adult with as low an excretion as that.

DR. KOPLIK: A low phthalein excretion is not inconsistent with complete recovery. In the last six months, we have been making phthalein tests in nephritis cases and on healthy children. We find that there may be a severe nephritis and quite a good phthalein excretion, i. e., 65 per cent. in two hours. On the other hand, there may be a very low excretion of phthalein—30 per cent. —as in a case of pyelitis, a very severely ill child; yet the child may recover completely. If the phthalein excretion runs low in children, this fact is not of such serious significance as to exclude complete recovery. The phthalein elimination test should be made in all cases of children suffering with nephritis before a surgical operation is undertaken. One case of decapsulation that I had proves this. I am sorry that we did not make the phthalein test in that case. As it was, the child passed into uremic coma immediately after the operation. If we had made the test, it might have protected the child from operation. She would then have weathered the gale, and we might have been able to operate successfully later.

DR. TILESTON: In answer to Dr. Freeman I would say that last year I saw a case in an adult with hemolytic anemia, in which the excretion was zero; yet she recovered. The phthalein test shows only the function of the kidney at the time the test is made; and a total suspension of function may be compatible with complete recovery. It is the same with nitrogen retention. A very large figure for total nitrogen in the blood is compatible with recovery, if due to a temporary condition. We had a case of acute intestinal obstruction, which went up to 150 mg.; but the patient, an adult, recovered.

THE VALUE OF THE X-RAY IN INTRATHORACIC LESIONS IN CHILDREN

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I have been much impressed in discussions on the X-ray by the difference of opinion as to the value of X-ray and by the considerable number of careful observers who seem to believe that the X-ray is of little value and causes mistakes in diagnosis. It is my belief that the men who have this opinion have never made free us of a well-equipped X-ray laboratory presided over by an expert radiologist. Disappointment in the use of this means of diagnosis may result from expecting too much from it. Alone, it is generally of little value, but, like other evidence, in combination with clinical history and physical signs, it may be conclusive.

Auscultation, our most valuable means for determining the character of intrathoracic lesions, is of materially less value than auscultation in combination with percussion, and auscultation and percussion aided by a good X-ray plate may fix a diagnosis that might otherwise remain obscure, for the X-ray may show us lesions in the chest of which we can obtain no knowledge by any of our means of physical examination.

The results of radiography vary with the part that is to be radiographed. A good X-ray of bones is of course most readily obtained and gives most important results. X-rays of the abdomen in children are frequently disappointing, although occasionally they give important information. Radiographs of the chest, however, in children are a material aid in diagnosis.

The X-ray is probably of most value in making the diagnosis of miliary tuberculosis, often in determining a pneumonia of which we get no physical signs, in making a differential diagnosis between empyema and pneumonia, or in corroboration of a diagnosis of diaphragmatic hernia, while in lesions of the heart it furnishes reliable information as to enlargement, in the modification of the shape of the heart, in dilatation or the presence of exudate, and will often differentiate for us plastic exudate from fluid.

Concerning its use in the diagnosis of miliary tuberculosis there is probably more accord than concerning other conditions, for we all know that the physical signs of miliary tuberculosis in the lungs are those only of a slight bronchitis. We see repeatedly children with a temperature, sibilant and sonorous râles, sometimes subcrepitant, of the significance of which we can get no definite estimation without the X-ray. A von Pirquet test, if positive, will render the diagnosis of tuberculosis more probable, but still leaves us with the possibility of a simple bronchitis in a child with a tuberculous lymph node somewhere in the body. Having, however, obtained a characteristic picture by X-ray we no longer need to speculate on the lesion present.

The diagnosis of cases of pneumonia in children, although usually evident to an intelligent pediatrician, we have learned from the use of the X-ray, is occasionally impossible. Cases of well-defined pneumonia may give rise to no physical signs and even after the pneumonia has been localized by the X-ray a subsequent physical examination may give negative results.

Diagnosis of fluid in the chest may often be corroborated by an X-ray.

The presence of air in the chest is also well shown in the X-ray, and if there occurs a combination of air and pus one gets a pus level which is very characteristic.

The question often arises whether a murmur heard over the heart is a so-called hemic or anemic murmur or a murmur due to a damaged valve in the heart. Many children are prevented from taking the exercise which they need and should have for their physical development and health by the presence of a cardiac murmur without cardiac disease. In such cases an X-ray picture of the heart gives one an excellent basis for an opinion as to the origin of the murmur.

In diseases of the heart in children the X-ray gives us, I believe, a most valuable indication of the amount of damage to the heart by the size and shape of the heart shadow, and successive pictures provide us with one of our best means for the control of exercise in these cases. For such control, of course, the temperature and pulse rate are of great value, but the X-ray picture will occasionally change our method of treatment to the advantage of the patient.

Another condition shown well by the X-ray, of which we get little evidence otherwise, is enlargement of the thymus gland which gives

a broad shadow above the heart. Enlargement of the bronchial and mediastinal lymph nodes may also be brought out by the X-ray.

In one other condition I have found the X-ray useful and that is in corroboration of a diagnosis of diaphragmatic hernia, and I can show you some excellent pictures of X-rays taken of a case of this sort.

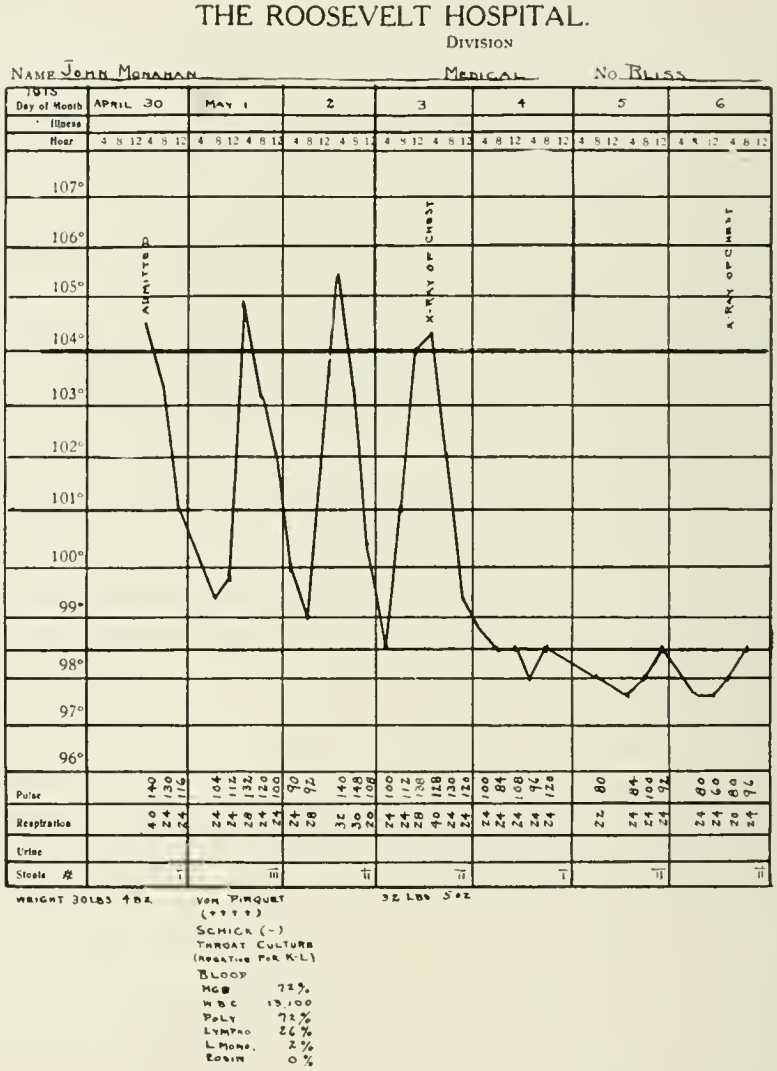

Fig. 1.—Chart of a case (Case 1) of pneumonia without physical signs but showing a shadow on the X-ray plate.

In conclusion I would say that the X-ray furnishes a most important means in reaching a definite diagnosis of intrathoracic lesions. It should not be neglected in any obscure case. It is particularly adapted to children, as one can get a better picture of a child usually than of an adult, and because children, even when sick, can easily be carried to an X-ray laboratory.

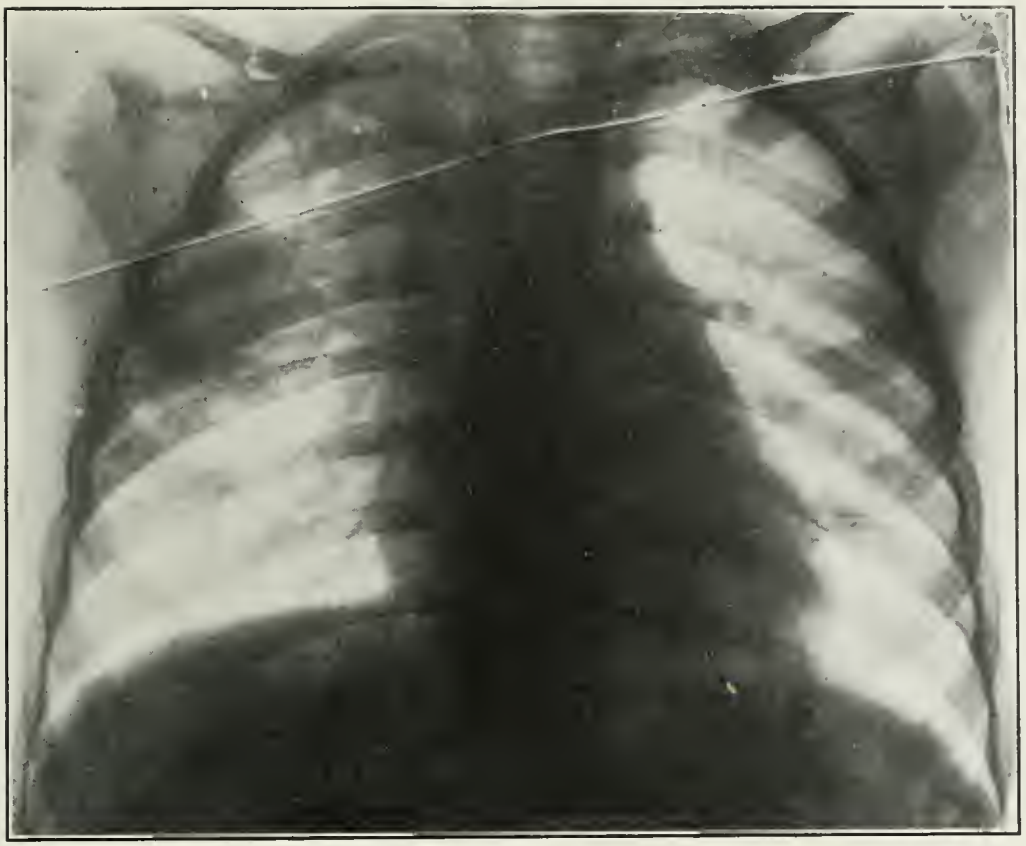

Fig. 2.—Radiograph of thorax of Case 1, showing well-defined pneumonia of the right middle lobe.

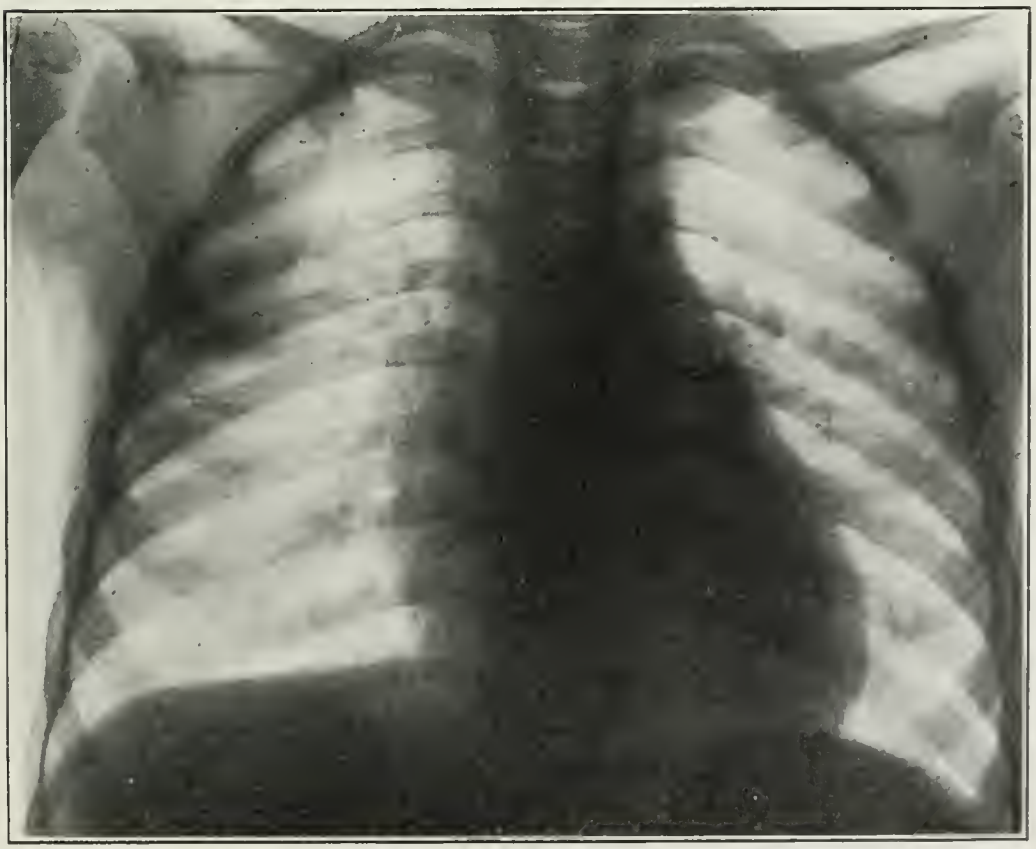

Fig. 3.—Radiograph of same case three days later.

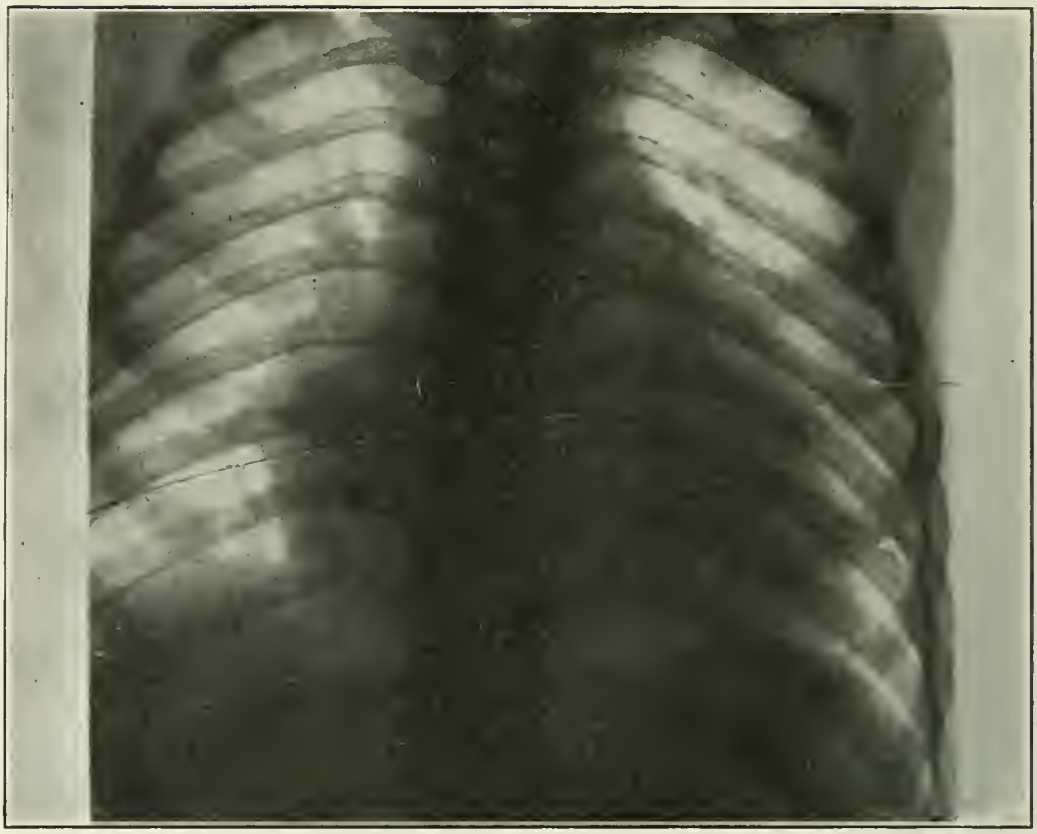

Fig. 4.—Radiograph of Case 2, showing heart shadow on admission.

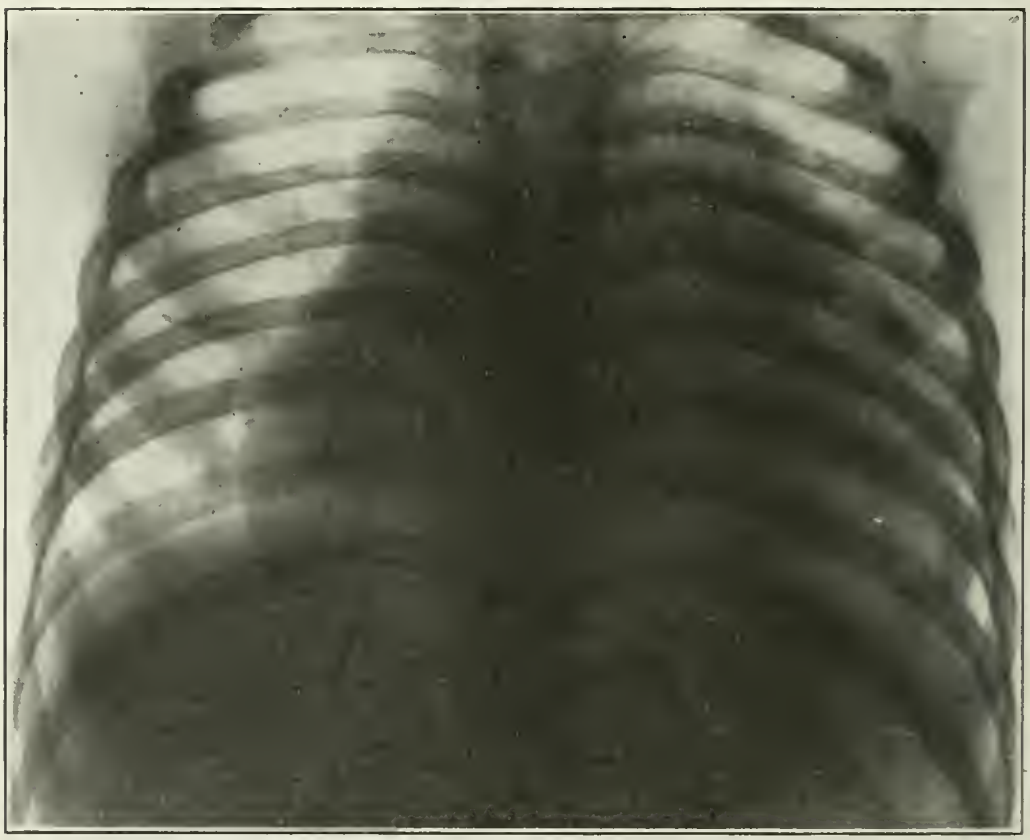

Fig. 5.—Radiograph of Case 2, showing enlarged heart shadow due to plastic exudate.

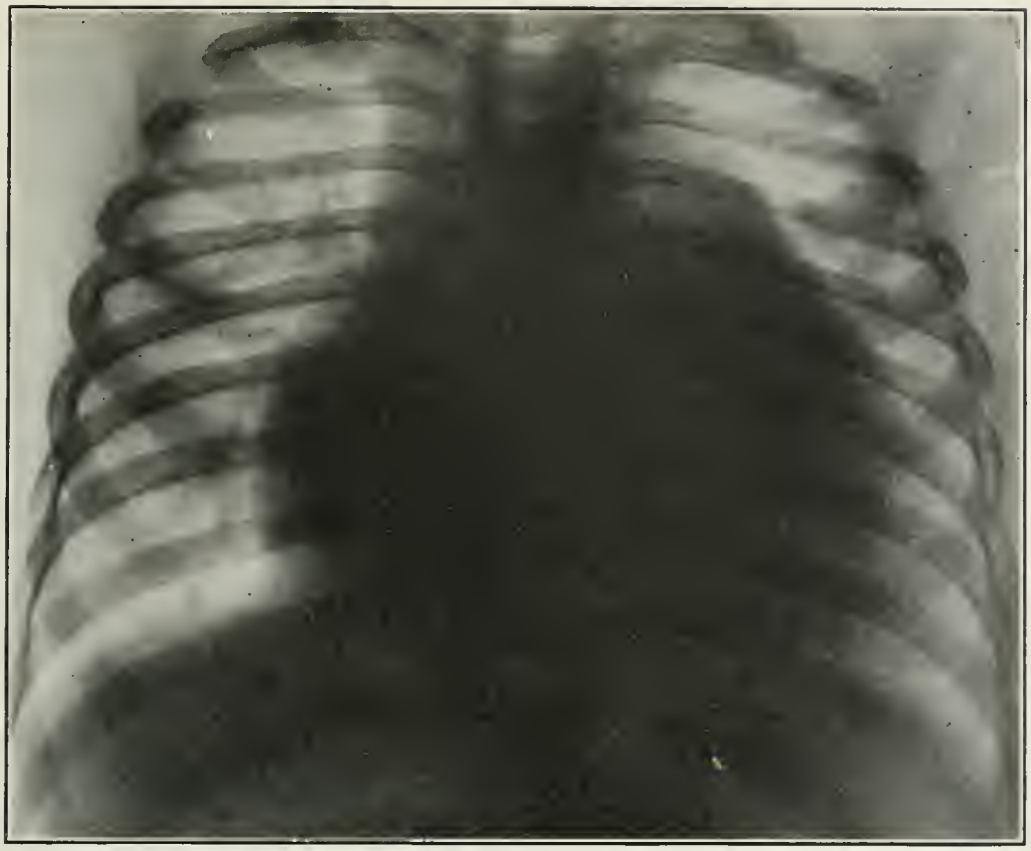

Fig. 6.—Radiograph of Case 2 eight days later, after improvement in general condition and physical signs.

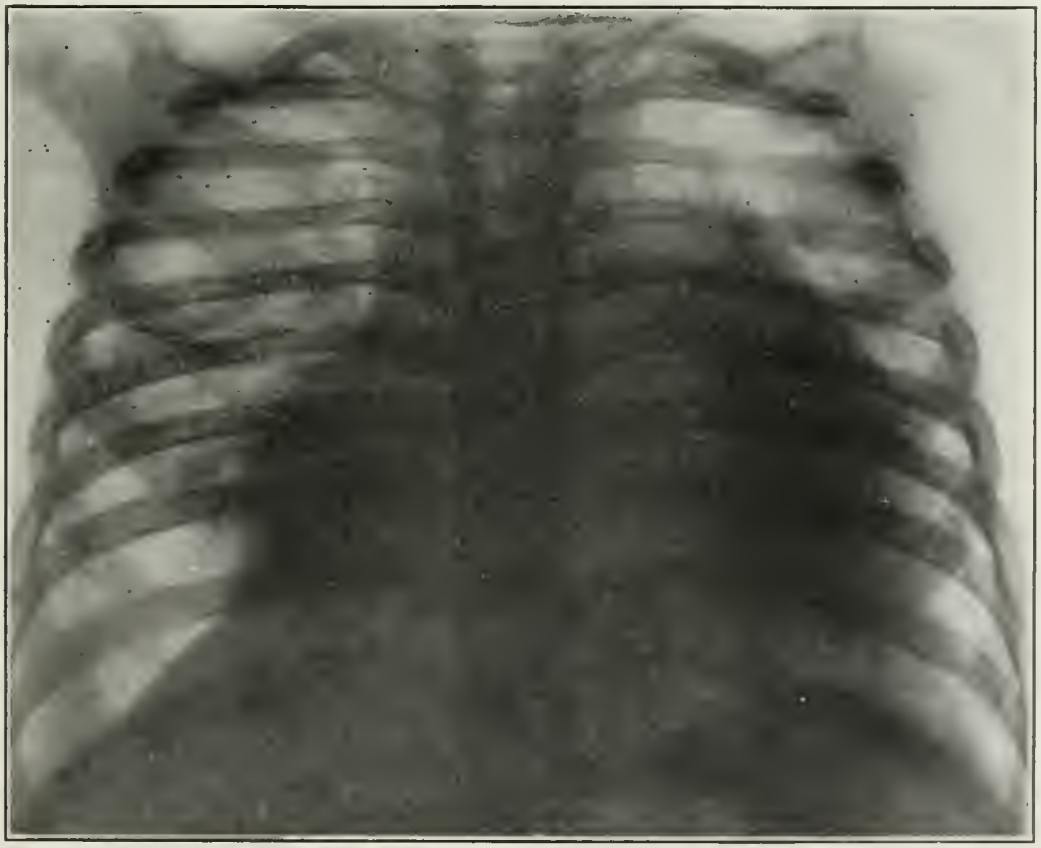

Fig. 7.—Radiograph of Case 2 showing presence of pericardial fluid by obliteration of the normal cardiophrenic angle, at the junction of the shadow of the right border of the heart and the diaphragm.

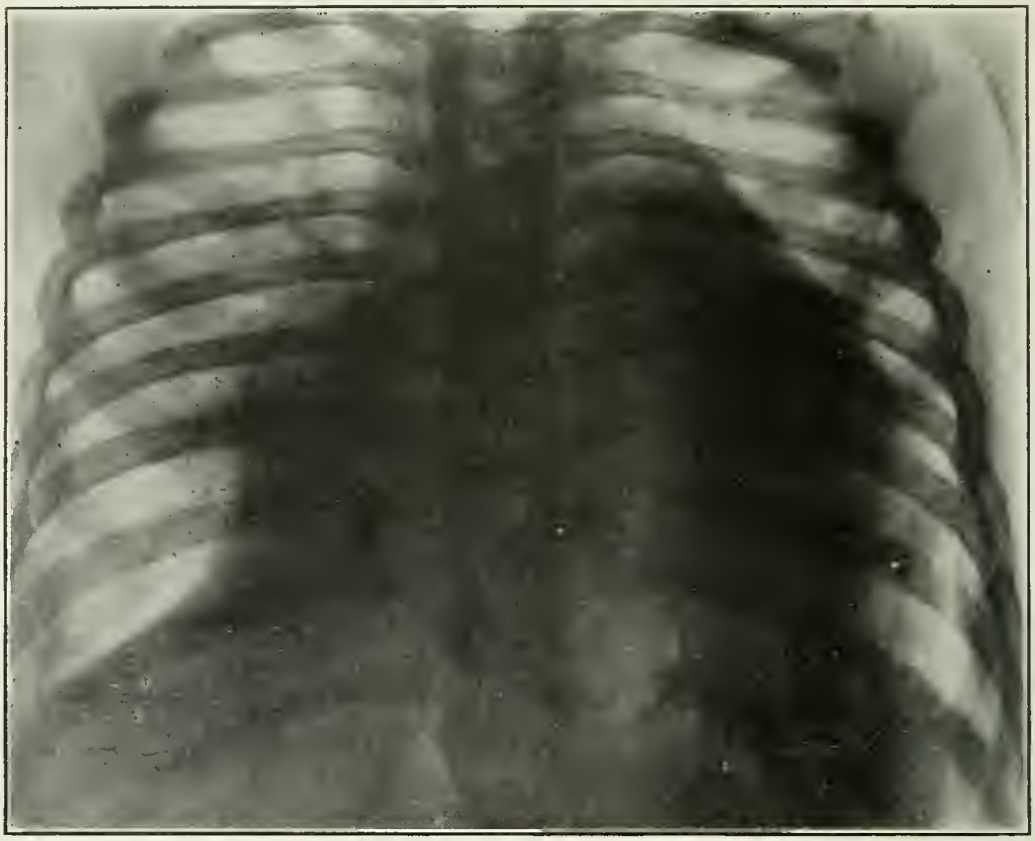

Fig. 8.—Radiograph of Case 2 a week later than Figure 7 with fluid reduced but still present.

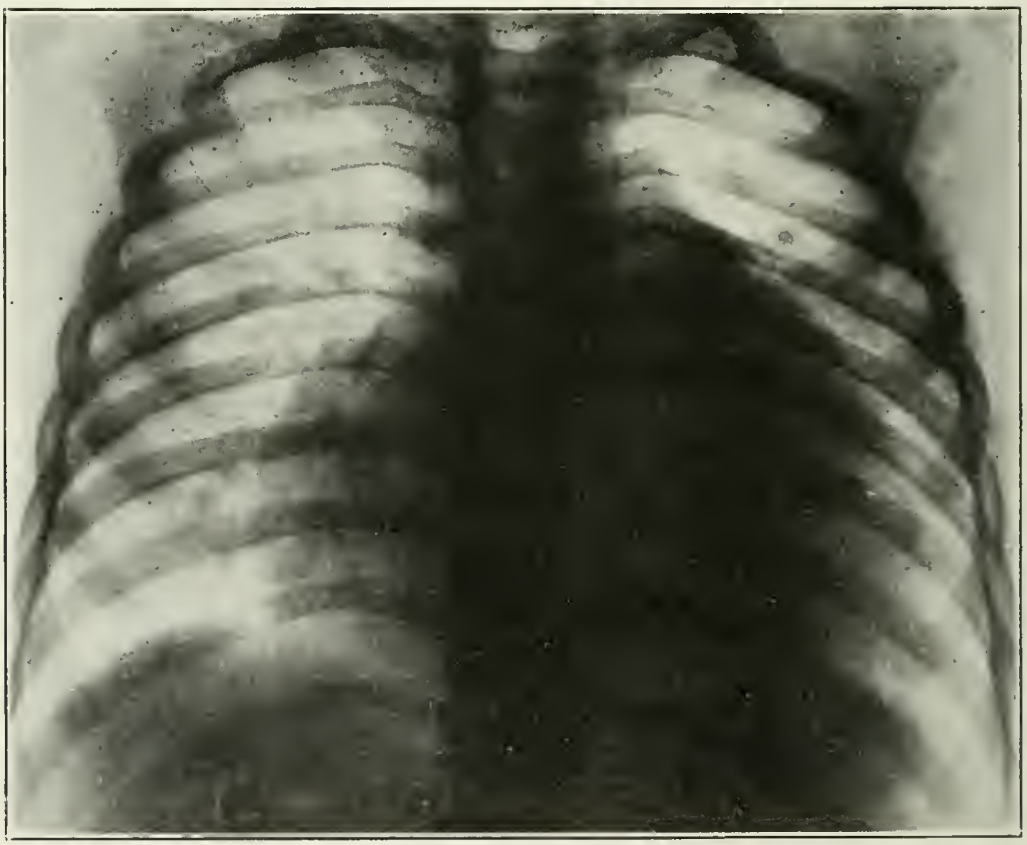

Fig. 9.—Radiograph of Case 2 six months later when the child was fairly well.

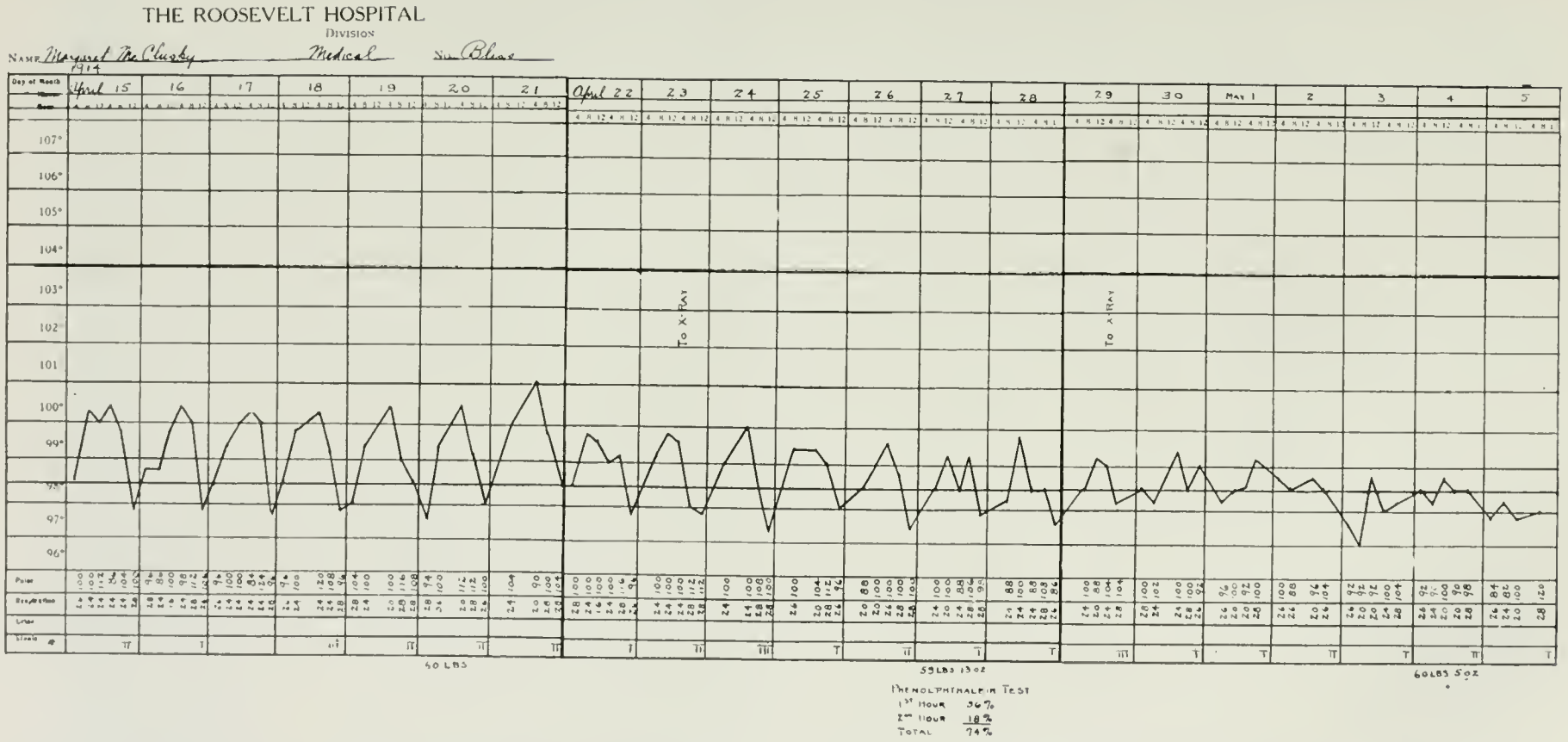

Fig. 10.—Chart of Case 3, showing the gradnal reduction of temperature to normal after April 23, when the second X-ray plate was made and the child was put to bed.

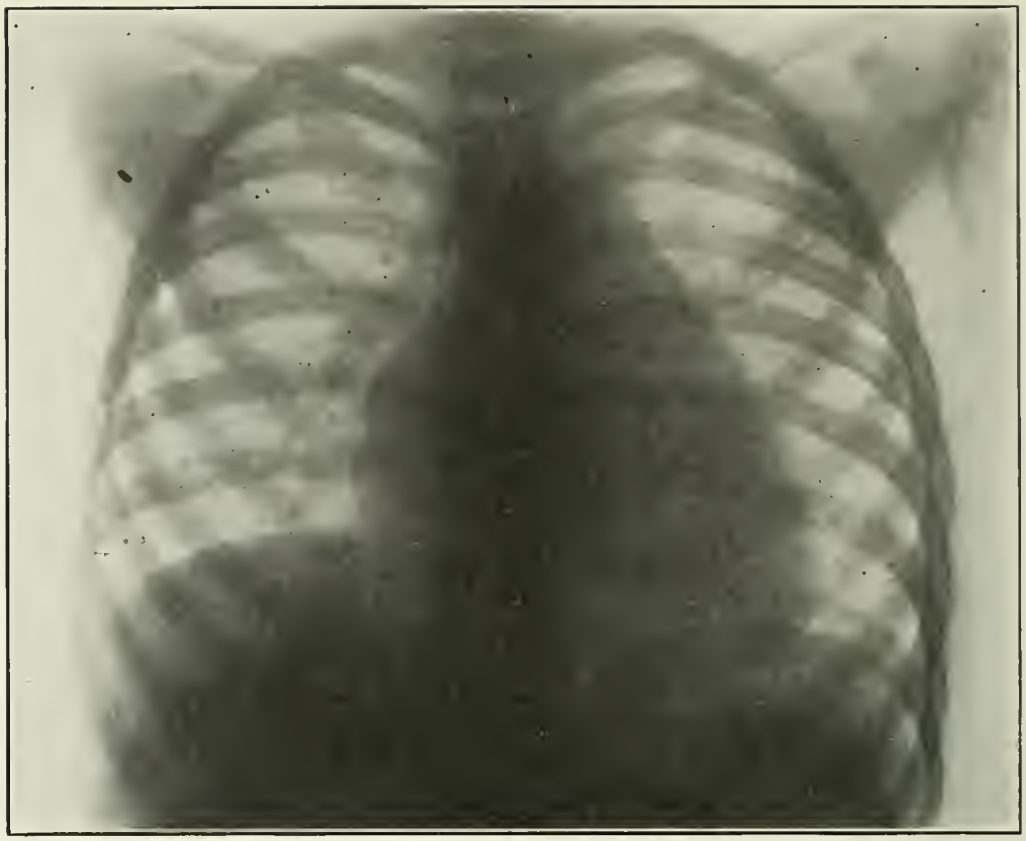

Fig. 11.—Radiograph of Case 3 on admission.

Fig. 12.—Radiograph of Case 3 twenty-four days later after being allowed up.

[A series of lantern slides was then shown to illustrate the points made.]

The plates of three of these cases are here reproduced:

The first case (Fig. 1) is that of a child who came into the ward with a remitting temperature with almost no record of accelerated respirations, although on counting them on one occasion at the bedside I found them to be 40. Physical examination showed good breathing and percussion note and voice over both lungs, and we examined care-

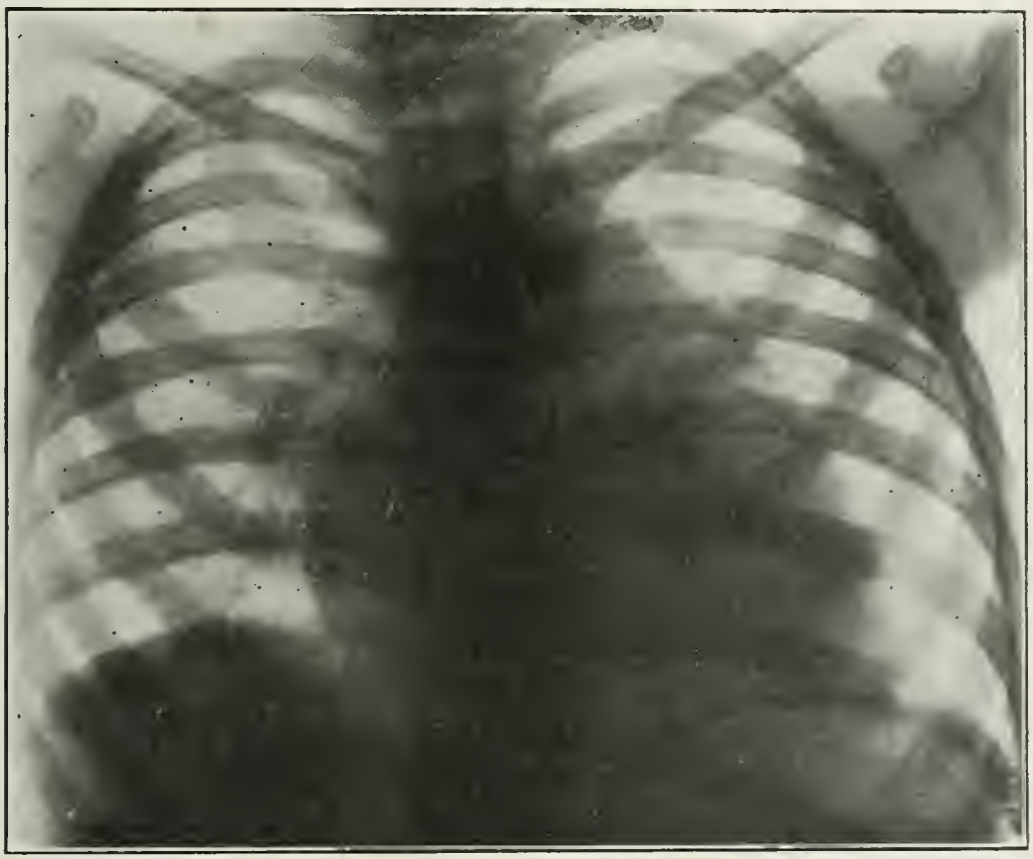

Fig. 13.—Radiograph in Case 3 after six days in bed.

fully the ears, urine, abdomen and other parts of the body for the cause of this temperature with negative results. The X-ray plate (Fig. 2), however, showed us a well-defined pneumonia. After we had seen the X-ray plate we went back to the ward and re-examined the child carefully, knowing where the signs ought to be, but we could obtain no signs. A second X-ray plate (Fig. 3), taken three days later, confirmed the first.

The second case (Fig. 4) shows a very large heart. It is that of a boy who came into the Roosevelt Hospital with a heart apex displaced downward and outward, a heart that percussed very large and a rapid pulse and dyspnea. He had a systolic and presystolic murmur at the apex as well as a systolic murmur over the mitral area at the base. Six weeks after admission he developed pericardial friction sounds followed by a diminution in audibility of the heart sounds, and the X-ray plate (Fig. 5) showed an increased heart shadow due to this exudate. The boy then improved, and the plate made eight days later shows a much smaller heart shadow (Fig. 6). Sixteen days later the boy's condition became very bad with marked edema of the legs and scrotum, with fluid in the left pleural cavity, and another X-ray plate (Fig. 7) showed the presence of a moderate amount of fluid in the pericardium. Under digipuratum the edema rapidly disappeared and another X-ray plate (Fig. 8), taken a week later, showed a diminution of about one-half of the amount of fluid in the pericardium, while a few days later an X-ray plate gave us accurate information that no more fluid existed in the pericardium. Subsequently, as the boy improved, the heart became smaller, and Figure 9 shows the heart shadow six months later when the boy was up and about with fair compensation.

The chart (Fig. 10) is that of a child (Case 3) with a mitral lesion, who on X-ray (Fig. 11) showed a large heart. She was kept in bed for some days and then allowed up a part of the day, and then a whole day because her compensation was improving, she was gaining in weight and was looking better. She was, however, having a little elevation temperature, so that we had an X-ray photograph made twenty-four days after admission. This plate (Fig. 12) showed the heart to be rather larger, a little fuller on the left side, and showed us also that we had been deceived in thinking that the child's heart was better because her general condition had improved. On this account she was put to bed. Her temperature then became normal and her heart shadow again improved (Fig. 13).

Our X-ray plate in this case gave us information that we had been unable to obtain by other clinical measures, and led us to a correct method of treating the child. The X-ray, therefore, not only is an aid in diagnosis, but may furnish indications for treatment.

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DISCUSSION

DR. HOWLAND: I cannot agree with Dr. Freeman that the Roentgen ray shows clearly an enlargement of the thymus gland. In almost all cases that I have seen in which it was asserted by roentgenologists from an examination of the plates that an enlarged thymus was present, the shadows turned out to be due to some other cause—most commonly to an enlargement of the mediastinal glands, due to tuberculosis.

There is one other thing that I should like to call attention to, and that is the shadow cast by fluid in the pericardium. Normally the cardiohepatic angle is an acute angle. When fluid collects, the angle becomes obtuse at first; but when more fluid collects, so that the pericardium is completely filled, and much distended, the cardiohepatic angle again becomes an acute angle; because the fixed point of attachment does not allow expansion to the right or the left, but only in the center. Therefore, the pericardium bulges out and produces an acute angle. I have had several series of observations on patients with pericarditis with whom the angle was first acute, then obtuse, and then acute again.

DR. KOPLIK: I think that we should be very cautious about allowing the radiographer to make a diagnosis for us, from findings in the chest shown in the radiograms. There are two things that I have experienced disappointment in. One is the presence of fluid or thickening of the pleura, the other a diagnosis of cavity. I recently had a case of aspiration pneumonia in which the clinical diagnosis was cavity. The Roentgen ray showed what was apparently a cavity in the upper part of the left lung. The only thing that saved the boy from operation (the plate having been seen by a surgeon, who insisted that the patient should be operated on, because there was a cavity with fetid sputum) was that by physical signs the lower part of the lung showed a pneumonia. The boy made a complete recovery. He must have had fetid pneumonia after tonsillotomy, which simulated cavity-formation in the upper lobe, and in the lower lobe, a pneumonia. The radiographer, after having seen two or three plates, withdrew the diagnosis of cavity; but not in time to have avoided operation, had there been compliance on the part of the clinician.

I have also had cases in which the report was a thickened pleura, and I insisted that fluid was present; after a search, we actually found the fluid.

Another very deceptive finding is that of spots which seem to indicate, according to the radiographers, tuberculosis of the lung. We should be cautious about accepting their diagnosis of these areas. We cannot today be absolutely certain in regard to the interpretation of Roentgen-ray plates, until we have more anatomic basis for the interpretations of these shadows. Our post mortems have not been sufficient to allow the radiographer to make a definite diagnosis on which the clinician should confidently proceed.

DR. DUNN: I should like to back up what Dr. Koplik has just said about caution in making a diagnosis from Roentgen-ray plates. I have had, at the Infants' Hospital, twenty-four post mortems on babies, in whose cases the plates had shown some condition on which diagnoses were made. In three cases in which the diagnosis of fluid in the chest had been made, no fluid was found, but simply fibrous adhesions of the pleural cavity. We found miliary tuberculosis frequently at postmortem examination in cases in which the Roentgen ray had not shown it. I do not think that most plates will show tuberculosis of a pure miliary type. We had among these post mortems a case diagnosed as tuberculosis, the postmortem of which showed old bronchopneumonia with

fibrosis organization and bronchiectasis. Comparing the Roentgen-ray diagnoses with the postmortem findings in this series of cases, we discovered that they did not agree in fully half the twenty-four cases.

DR. HOLT: In connection with the differences between the Roentgen-ray diagnosis and the physical findings, I would mention a recent communication of Dr. Roper to the New York Academy of Medicine, presenting a series of cases like that of Dr. Freeman. The differences in the interpretations of Roentgenograms taken of the same child on successive days were so great as to be positively amusing.

Most misleading are the shadows often ascribed to enlarged bronchial lymph nodes. It is indeed a rare plate that does not show something that may be interpreted in this way. Such shadows are often due to bronchi, sometimes to full blood vessels. A child was recently seen with symptoms suggesting a foreign body in the bronchi. The diagnosis from the x-ray examination was general miliary tuberculosis with cavity. At necropsy the foreign body was found. It was a piece of a chestnut. There was no cavity, and no miliary tuberculosis. The shadows which had been interpreted as scattered tuberculous deposits were caused by the thickened bronchi in an emphysematous lung.

While the Roentgen-ray examination affords much assistance in the diagnosis of many pulmonary cases, if there is a disagreement between the physical signs and the Roentgen-ray picture, it is somewhat hazardous to act on the diagnosis of the roentgenographer.

DR. GITTINGS: I was much impressed with a paper recently read in Philadelphia by Dr. F. A. Craig, a member of the staff of the Phipps Institute for the Study and Treatment of Tuberculosis, on the subject of chronic, non-tuberculous lung affections, especially as they occur in children. Each case was studied by the Roentgen rays as well as clinically, and in 50 per cent. of the number the physical findings were not corroborated by the roentgenologist.

In view of the undoubted skill in physical diagnosis of the associates at the Phipps Hospital, the Roentgen-ray findings could only be interpreted as failures in a considerable proportion of the cases.

In the study of dissections of eighteen frozen bodies of infants, recently made, I found thymuses in seven instances of such size that they could hardly fail seriously to interfere with the differentiation from enlarged bronchial glands by means of the Roentgen ray. I am therefore inclined to be somewhat conservative in the acceptance of roentgenologic diagnoses of many pulmonary conditions.

DR. MORSE: It seems to me that this question of the use of the Roentgen ray in the diagnosis of conditions of the chest is really a very simple one. We all feel the same way about it, in reality. The Roentgen ray is merely a picture, to show the differences in the lights and shadows. It does not make a diagnosis, but is merely a means of helping us to make it. We should look on it in the same way as we do other means of diagnosis, and make the diagnosis on a combination of these. It is not the Roentgen ray that makes the diagnosis, but brains.

DR. COWIE: At the University Hospital we find the stereoscopic plate almost indispensable in the examination of the chest. Certain spots or areas which in the flat plate at times suggest quite strongly tuberculous foci (lymph nodes), in the stereoscopic plate may be seen to be one bronchi crossing

another. These spots or areas under the stereoscope resolve, so to speak, and disappear and one sees the bronchi or other overlapping structures in their correct position.

Another point I should like to call attention to is the importance of immediate percussion in outlining areas of consolidation in infants. Doubtless all are aware of the ease with which these small areas may often be discovered by this feeling, palpatory percussion, which so often go undiscovered by ordinary percussion. I have been able to verify areas discovered in this way by the roentgenogram. On the other hand, I have also been quite sure of slight areas of consolidation which did not show in the stereoscopic or flat plate, and the clinical symptoms were such as to support the percussion findings. A second plate, in this case, might have shown the area. The roentgenographic plate is a great help in diagnosis, particularly of conditions in the chest. It should, however, be considered only an adjunct. In determining whether areas of impaired resonance, dulness, or shadow are pneumonic, we should not overlook the importance of the leukocyte count.

DR. HAND: The Roentgen ray is of very great value, and the more we use it, the more we appreciate it. I think, however, that Dr. Freeman did not lay enough stress on its limitations, especially in pneumonia and empyema. The Roentgen ray will show consolidation; but consolidation of the lower lobe may resemble an empyema, and the Roentgen ray will not show at what distance from the front wall of the chest the condition giving the appearance of empyema is situated. This winter, there was a case in a child that I was sure was empyema following pneumonia. I had explored the chest twice without finding pus. The Roentgen ray showed a well-defined shadow. The lateral view was obscured by the shadow of the heart. We were able, finally, to locate the empyema.

In the diagnosis of heart conditions, I think the Roentgen ray is of very great value. I have had more discussions with my residents over the diagnosis of heart conditions than over that of pneumonias. They are apt to find murmurs that I do not hear; but those that I cannot hear do not worry me, because the future course, I am satisfied, will show that they have been functional murmurs. The Roentgen ray clears up the diagnosis very well in these cases.

DR. FREEMAN: I should not have bored you with these slides if I had not expected the sort of discussion we have had. I understand the limitations of the Roentgen ray; but I simply wanted to show a few cases in which I found it very useful as an aid in the diagnosis. My own feeling is that we expect too much of the Roentgen ray. One resident said to me: "The x-ray man did not send the diagnosis." "It is not his business to do so," I replied. "You go and tell him all you know about the case, and he will then help you to make a diagnosis." It is a method of diagnosis that, taken in connection with the other methods that we have at hand, is most useful and sometimes conclusive.

So far as Dr. Howland's remark about the thymus is concerned, I would say that I was unable to corroborate the Roentgen-ray diagnosis of enlarged thymus at necropsy.

A CHEMICAL STUDY OF WOMAN'S MILK, ESPECIALLY ITS INORGANIC CONSTITUENTS*

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AND

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No extended review of the literature on the chemistry of woman's milk will be attempted in this paper. The reader is referred for this to a résumé by Nothmann[1] in 1912 and another by Talbot[2] in 1914. Quite large series of analyses have been made by many observers in which only a determination of the organic constituents and the total ash of milk was aimed at. Among the most important publications are those of Leeds,[3] Meigs[4] and Adriance[5] in this country and those of Pfeiffer[6] and Schlossman[7] in Germany.

The fat and protein content of woman's milk are now pretty definitely agreed on. The methods followed by many chemists in the sugar determination, as we shall see later, are open to criticism; and even in the total ash estimation, errors have been made owing to faulty methods.

Considering how much work has been done on the chemistry of woman's milk, it is surprising that so few investigators have concerned themselves with the composition of the ash. With the exception of Harrington and Kinnicutt[8] who analyzed a single large composite sample, almost nothing has been published in this country and very little abroad on this subject. It is true that both here and abroad

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* From the laboratories of the Babies' Hospital and the Rockefeller Institute for Medical Research.

1. Nothmann: Jahrb. f. Kinderh., 1912, lxxv, 724.
2. Talbot: Am. Jour. Dis. Child., 1914, vii, 445.
3. Leeds: Reprint, Proc. Am. Assn. Adv. Sc., 1884.
4. Meigs: Milk Analysis and Infant Feeding, Phila., 1885.
5. Adriance: Arch. Pediat., 1897, xiv, 22, 85.
6. Pfeiffer: Verhandl. d. Versamml. d. Ges. f. Kinderh., Wien., 1894, p. 126.
7. Schlossmann: Arch. f. Kinderh., 1900, xxx, 288.
8. Harrington and Kinnicutt: Rotch, Pediatrics, 1906.

isolated analyses have been reported, but they have been mainly in connection with metabolism experiments and have frequently been made when the conditions were presumably pathologic. Even the writers who have undertaken to study the normal composition of the ash in woman's milk and who have been most extensively quoted in literature have made a surprisingly small number of observations.

The earliest modern investigator was Bunge[9] who published in 1874. Though his methods were exact, practically those in use today, so that his results can be relied on, yet his figures which have been so widely quoted were derived from two examinations of the milk of the same woman, one made on the fifteenth and the other on the eighteenth day of lactation. He used large samples, but he does not state that it was the twenty-four hours' secretion. Söldner,[10] whose work is also much quoted, published but six analyses, three of these being of colostrum and none being of milk at a later period than three and a half months. In only one instance was his examination of an individual sample. Pelka's[11] observations were but two in number, both made on composite samples. The single observations by Blauberg,[12] Abderhalden,[13] Birk[14] and de Lange[15] practically complete the list to which reference is made in literature on the salts of woman's milk up to the work of Schloss[16] in 1912.

The most important recent contribution on this subject has been made by the author last mentioned. His observations are much more numerous than those of any of the other writers. They were made on ten large individual samples of milk, eight of these being the total secretion for twenty-four hours; the other two were large samples collected during several successive days. In addition, two composite samples, obtained respectively from fifteen and sixteen women, were examined.

Schloss divides lactation into three periods: (1) colostrum period; (2) transition period extending from the colostrum to the end of the

9. Bunge: Ztschr. f. Biol., 1874, x, 295.
10. Cammerer and Söldner: Ztschr. f. Biol., xxxix, 173; xliv, 61.
11. Pelka: Ztschr. f. Kinderh., 1911, ii, 442.
12. Blauberg: Quoted by Engel in Sommerfeld's Handbuch der Milchkunde. Wiesbaden, 1909, 800.
13. Abderhalden: Personal communication quoted by Schloss.
14. Birk: Monatschr. f. Kinderh., 1910-11, ix, 595.
15. De Lange: Ztschr. f. Biol., 1900, xl, 527.
16. Schloss: Monatschr. f. Kinderh., 1910-11, ix, 636; x, 499.

fourth week; (3) mature, or as he terms it, the period of "ripe" milk. He concludes that though the absolute values, especially of total ash and ash constituents, show great differences in individuals, the ratio of the separate constituents to one another is fairly constant. He was particularly struck by the parallelism of the total nitrogen and total ash values. From his findings he concludes that, with the exception of fat, all the constituents of milk stand in a fairly definite ratio to one another. The high protein and high ash of colostrum milk, established by the earlier investigators, were confirmed by his findings. After the colostrum period these values sink rapidly, but no falling off was shown in his four mature cases taken between the twenty-sixth day and four and a half months. It was only in the milk of three women examined after ten months that a marked reduction was evident. There was no evidence to prove a relationship between the daily quantity and concentration.

In only one case were there high figures with a relatively small production of milk. The great variation in previously published figures, especially of calcium, he explains by the fact that most authors have analyzed only small portions of the twenty-four hours' secretion, and in many cases the milk was from mothers of rachitic children. Schloss concludes that there are not yet enough analyses, even including those of all previous workers, to establish a definite picture of the composition of woman's milk, particularly of the ash in the different periods of lactation.

Besides the work referred to on the entire ash, a number of authors have investigated separate salts of milk. Thus, a special study of the phosphorus has been made by Schlossmann.[17] His results from the analyses of the milk of thirty-one individual women show the following averages:

Colostrum period, 2 women	.0533
Transition period, 6 women	.0463
Mature period, 21 women	.0460
Late period, 2 women	.0360

The calcium content of milk in normal and various abnormal conditions has been studied quite exhaustively by Bahrdt and Edelstein.[18] They give results obtained by eight other investigators of normal milk, but the figures are chiefly from their own observations. They give the

17. Schlossmann: Arch. f. Kinderh., 1905, xl, 1.
18. Bahrdt and Edelstein: Jahrb. f. Kinderh., 1910, lxxii, Supplement, p. 16.

following values for CaO in the milk of eighty individual mothers of healthy children taken at the different periods of lactation, exclusive of authors whose results we have tabulated in our own paper. They may be grouped as follows:

Colostrum period, 4 women		.0476
Transition period, 23 women		.0397
Mature period, 51 women	1- 3 months (7) .0489 3- 5 months (32) .0411 6- 8 months (6) .0385 8-10 months (6) .0392	.0416
Late period, 2 women	14 months (1) .0452 16 months (1) .0341	.0396

In these figures it will be noted there is very little variation after the colostrum period.

The iron content of woman's milk has also been studied by Bahrdt and Edelstein.[19] They employed the method of Neumann, in which the iron is brought down by a zinc reagent, filtered off, and dissolved in HCl; potassium iodid is then added and the freed iodin titrated with sodium thiosulphate. The amounts used for single determinations varied from about 708 c.c. to 1,300 c.c. The samples were made up of portions collected through periods of from two to four days. The milk of three nurses was studied at different times; the periods of lactation in all were between the twenty-fourth day and the sixth month. They obtained a range of .00012 to .00029 per cent. with an average value for Fe_2O_3 of .00017 per cent. The individual variations were slight.[20]

These figures for iron correspond closely with those of Söldner who from examinations of two large samples of milk taken between the third and twelfth days gives values of .00021 and .00013—an average of .00017 per cent. Iron values given by several writers are considerably higher than those quoted; but many of them have been obtained from such small samples that the results of the analyses cannot be relied on.

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19. Bahrdt and Edelstein: Ztschr. f. Kinderh., 1910-11, i, 182.

20. Edelstein and Csonka (Biochem. Ztschr., 1912, xxxviii, 14) have recently studied the iron content of cow's milk, using large samples for analysis. When milk was carefully drawn they obtained a range of values from 0.4 to 0.7 mg. per liter, with an average of 0.5. They conclude that the iron in cow's milk is only about one-third that in woman's milk. In point of fact the amount is so small as to be negligible.

From the great interest which has recently developed in the metabolism of the salts, it seemed to us desirable that the question of the composition of the ash in woman's milk should be studied anew and on a more extended scale than hitherto, and that further, an effort should be made to learn more of the individual variations in the different salts by the use of large individual samples.

The chief purpose of the investigation, the results of which are herewith presented, was a study of the composition of the ash in woman's milk at the different periods of lactation. Incidentally, we have made determinations of the other constituents of milk—fat, sugar and protein—and have made a study of the methods commonly employed in milk analysis.

In all, examinations have been made of thirty-two large individual samples—in most cases the entire twenty-four hours' secretion—and of six composite samples. Following the classification suggested by Schloss, these cases have been grouped as follows: In the "colostrum" period, two individual and three composite samples; in the "transition period," three individual and three composite samples; in the "mature" period (one to nine months) seventeen individual samples. We have classed separately in a "late" period ten cases of milk from the tenth to the twentieth month. As we were endeavoring to secure normal values, only the milk of apparently healthy women with healthy children was taken.

The value of the observations it seems to us is enhanced by the fact of the large individual samples obtained for analysis. Of those who have previously studied this subject only Schloss appears to have appreciated the importance of securing for examination the twenty-four hours' secretion from a single individual. The observations we have made on the milk of the colostrum and transition periods have not quite the same importance as those of mature milk, since in a number of instances only composite samples were available for analysis.

The results of many of the published analyses of breast milk are open to criticism, since such small samples were used for study. This applies of course chiefly to the ash, but it has also some importance in the estimation of the other constituents. As already suggested, the methods employed by many authors are now known to be unreliable, while others make no mention of methods used. For comparison with

our own results we have brought together the figures for ash analyses from the other investigators in this field whose methods could be relied on.

METHODS EMPLOYED

Nitrogen.—The *Total N* was determined in both liquid and dried samples by the Kjeldahl-Gunning method. The casein was precipitated by dilute acetic acid in a cold solution and the N determined in the filtrate, thus giving, first, the percentage of total protein which is casein, and secondly, the percentage of protein not precipitated by acetic acid. The latter figure necessarily includes any nonprotein nitrogenous substances which are present in the milk; there is evidence that such substances exist. In calculating the total protein as six and a quarter times the N there is therefore a slight error.

Fat.—The fat was determined in dried material by extraction with ether according to a modification of the Soxhlet method.

Sugar.—The question of the milk sugar content of the human milk does not seem yet to be definitely settled. Authors differ considerably in the range of values which they report, some, especially among the earlier investigators, giving figures below 6 per cent., while others obtain averages of above 7 per cent., and occasional figures run above 8 per cent.

Three general methods of sugar determinations have been employed: (1) Estimation by difference; (2) by the polariscope; (3) by some reduction method. In the first it has been customary to determine separately the fat, protein and ash and to regard the difference between the sum of these and the total dried weight as sugar. All the error in the analysis is thus thrown on the sugar. This method has been and still is much used, but is open to very obvious objections. Polariscope readings require considerable correction and are regarded as unreliable by several authors, including Reiss and Sommerfeld.[21] They may be too low because of the presence in the milk of substances which may cause rotation to the left.

Most of the figures for milk sugar reported have been obtained by some reduction method. Reduction methods may give too high figures because of the presence of other reducing substances than lactose. Schlossmann used a reduction method but obtained the value for the reduced copper by weighing instead of by titration. His range is from 5.2 to 10.9 per cent. Söldner used the same method and reports values from 5.35 to 7.52 per cent. If there is any difficulty due to the presence of reducing substances other than lactose, it is evidently not avoided by these investigators. Lust[22] gives for twenty-five women a range of 5.7 to 8.5 per cent., averaging 7.1 per cent. He also used a reduction method but made a colorimetric determination of the reduced copper. Schloss employed the titration method, but considers it inexact and does not include his results in his tables; his figures for sugar ranged from 6.38 to 7.9 per cent.

In our analyses the sugar was estimated after removal of the protein by boiling and then adding dilute acetic acid. The sugar was then determined by a titration method with Fehling's solution, in which the copper oxid is held in solution by potassium ferrocyanid. It was found that this method gave almost invariably higher results than the polariscope, but that it agreed very well with

21. Reiss and Sommerfeld in Sommerfeld's Handbuch der Milchkunde, 1909.
22. Lust: Monatschr. f. Kinderh., 1912, vi, 236.

other reduction methods, including the Volhard. Both the reduction methods and the polariscope determinations are therefore also open to criticism. There cannot be said yet to have been devised a wholly satisfactory method for sugar determination in woman's milk.[23]

On the whole the indirect method of estimating the sugar by difference, although open to the most obvious objections, appeared in our work to give the most consistent results. If this method is followed, however, a definite procedure in drying must be employed. We have dried the samples to minimum weight over the water bath and then allowed them to come to constant weight in the air at room temperature. This last step was to make sure that the lactose when weighed should contain all its water of crystallization. Cammerer and Söldner showed that the dried matter at equilibrium with the air includes the water of crystallization of milk sugar, but that if milk is brought to a constant weight in vacuo at 98 C. the lactose is in an anhydrous condition. The figures given in our tables represent the lactose with its water of crystallization. The lactose in an anhydrous form weighs 5 per cent. less. Most authors do not state which form of lactose their figures indicate. In our table we have given both the figures obtained by the reduction method and also those in which the estimation is by difference.

Ash.—The greater part of the twenty-four hours' secretion was dried on a steam bath until it reached a constant weight in equilibrium with room temperature and humidity. In this dried material the total ash and the separate ash constituents were determined. The method of ashing is of considerable importance. The one employed is that described by Karl Stölte;[24] a sufficient sample of the dried substance, finely ground, is weighed into a platinum dish, which is set on pieces of broken pipe-clay inside a porcelain dish of a diameter 1 to 2 inches greater than that of the platinum dish. Low heat from a large-sized Teklu burner is applied to the porcelain dish until the material is well charred; then the heat is gradually increased to the greatest possible point. When most of the black has disappeared, the platinum dish is covered by a piece of platinum foil and ignition continued until ashing is completed. This method seems to be especially advantageous in connection with the determination of sodium and potassium, since it is found that pure sodium chlorid and potassium chlorid subjected to this treatment for hours lose no weight whatever. Ash obtained in this way was used for the determination of calcium, magnesium, phosphorus, sodium and potassium.

To avoid the possibility of a slight loss of chlorin during the breaking down of the organic compounds, this constituent of the milk was determined directly

23. Since the greater part of this work was completed, a new method for removing the protein from milk, preparatory to sugar determination, has been suggested by Hill of Ithaca (Jour. Biol. Chem., March, 1915). To precipitate the protein after boiling, colloidal iron is added to the specimen of milk. This method was proposed for cow's milk. In applying this to woman's milk we have found it advantageous to add a few drops of a saturated solution of magnesium sulphate. In certain samples of milk it is impossible to obtain a clear filtrate with the acetic acid precipitation. In such cases the new procedure is of much value. By means of it we have never failed to obtain a clear filtrate. The application of this method, however, would affect the result in only a very small number of the analyses given in this paper.

24. Stölte: Biochem. Ztschr., 1911, xxxv, 104.

in the dried material. We have followed the method of removal of the protein by ferric alum and nitric acid, and titration of the chlorids in the filtrate according to Volhard. This is similar to the method chosen by Schloss after he had carefully tested it in comparison with other methods commonly used.

Calcium, magnesium, sodium, potassium and *phosphorus* were all determined by the usual methods. Calcium was precipitated as oxalate and weighed as oxid. Magnesium was precipitated as magnesium ammonium phosphate and weighed as pyrophosphate. Sodium and potassium were separated as chlorids and the potassium determined in the combined chlorids by precipitation with platinic chlorid. By the use of the Stölte method of ashing just described, the danger of volatilization of potassium and sodium chlorids, both in the initial ashing and at the stage of driving off ammonium salts, is entirely avoided. Unless this or some similar precaution is taken the values obtained for potassium and sodium are absolutely unreliable. Phosphoric acid was precipitated as ammonium phosphomolybdate; this was dissolved by ammonia and magnesium ammonium phosphate, precipitated by magnesia mixture and weighed as pyrophosphate.

The fat, sugar, protein and total ash in milk of the different periods are given in Table 1.

Colostrum.—The chief characteristic of the milk of the colostrum period is the high protein and the high total ash. The ash in one sample (No. 3) was so much lower than all the others that it must be regarded as an exceptional individual variation. Excluding this one the average ash for the period was 0.3077, the average protein 2.25 per cent. These figures correspond fairly well with those published by other observers. The specific gravity differs little from that of the milk of other periods.

Our values for sugar are somewhat higher than those reported by other investigators. The sugar figure was obtained by reduction in but a single sample; in the others it was estimated by difference. The reason for this was that our chief purpose was a study of the salts of milk, and it was sometimes impossible to do both determinations with the amount of milk which could be obtained for examination. The fat for all the samples analyzed averaged 3.15 per cent. But one of the individual samples which was taken at the very end of the colostrum period was unusually high, 4.43 per cent. An average of the remaining four analyses, including three composite and one individual sample, was 2.83 per cent., which is probably much nearer the usual fat content of colostrum milk. It corresponds with the results obtained by others.

TABLE 1.—Percentage Composition of Woman's Milk

A. Colostrum Period (1 to 12 Days)

No.	Age of Woman, Yrs.	Age of Child, Days	No. of Child	Sample	Amt. in c.c.	Sp. Gr.	Total Solids	Fat	Sugar by		Protein			Ash
									Reduction	Difference	Total	Casein	Albumin	
1	19-21	3-4	....	Composite, 5 women	295	.....	12.87	2.85	....	7.66	2.06	..	....	.2960
2	18-25	3 5	....	Composite, 6 women	960	1.032	12.68	3.30	6.50	7.09	1.96	.26	1.70	.3312
3	....	5-7	....	Individual	320	1.035	12.83	2.13	....	7.92	2.60	...	....	.1747
4	....	5-8	....	Individual	240	1.032	15.05	4.43	....	7.16	2.44	...	....	.2921
5	20-25	5-12	....	Composite, 4 women	210	.....	13.67	3.05	....	8.12	2.19	...	....	.3117

B. Transition Period (12 to 30 Days)

6	16-21	12-30	....	Composite, 4 women	285	.....	15.66	5.64	....	8.18	1.61	...	....	.2335
7	32	14	....	Individual	215	1.032	10.36	1.33	....	7.76	1.06	...	....	.2132
8	20	15-18	....	Composite, 2 women	490	1.032	12.74	3.89	....	7.24	1.36	...	....	.2471
9	19-32	14-28	....	Composite, 5 women	175	.....	14.18	4.01	....	7.88	1.99	...	....	.3042
10	18	21	....	Individual	175	.....	13.77	....	....	....	1.42	...	....	.2262
11	19	21	....	Individual, 24 hours	975	1.032	13.66	3.96	7.80	7.73	1.75	.45	1.30	.2204

C. Mature Period (1 to 9 Months)

		Mos.												
12	18	1	1	Individual, 48 hours	1,075	1.024	9.81	3.07	5.54	5.44	1.17	.37	.80	.1825
13	32	2	2	Individual, 24 hours	975	1.032	10.30	1.86	8.20	7.19	1.03	.40	.63	.2200
14	24	2	3	Individual, 24 hours	1,100	1.031	11.82	2.83	7.86	7.73	1.07	.41	.66	.1902
15	26	3	2	Individual, 36 hours	1,025	1.033	10.54	1.67	8.38	7.82	0.88	.04	.84	.1717
16	25	3	2	Individual, 24 hours	800	1.036	12.16	2.93	7.05	8.06	0.96	.46	.50	.2127
17	23	3	1	Individual, 24 hours	900	.....	12.05	2.87	7.78	7.73	1.23	.51	.72	.2135
18	32	3	2	Individual, 24 hours	850	.....	14.43	4.53	7.33	8.18	1.50	.64	.86	.2254
19	27	3½	2	Individual, 24 hours	950	1.031	13.11	3.89	8.38	7.72	1.26	.46	.80	.2433
20	23	3¾	1	Individual, 24 hours	880	.....	13.45	3.74	7.27	8.36	1.16	.52	.64	.1914
21	39	4	2	Individual, 24 hours	1,050	1.033	11.31	2.59	8.45	7.50	1.01	.34	.67	.2090
22	23	4	1	Individual, 24 hours	975	1.032	12.18	3.19	8.11	7.65	1.13	.36	.77	.2141
23	26	5	1	Individual, 24 hours	975	1.031	12.38	3.76	8.38	7.29	1.10	.45	.65	.2281
24	37	6	2	Individual, 48 hours	975	1.033	11.53	2.15	8.10	8.01	1.18	.36	.82	.1922
25	30	6	4	Individual, 36 hours	1,150	1.030	12.50	3.26	7.98	8.05	1.12	.53	.59	.1590
26	30	7	2	Individual, 24 hours	840	.....	14.13	5.48	7.48	7.11	1.29	.52	.77	.2402
27	22	8½	1	Individual, 48 hours	960	1.033	13.20	4.42	7.75	7.26	1.31	.53	.78	.2158
28	28	9	1	Individual, 2 days	960	1.033	11.86	3.27	7.60	7.16	1.23	.42	.81	.1974

TABLE 1.—(*Continued*)

D. LATE PERIOD (10 TO 20 MONTHS)

No.	Age of Woman, Yrs.	Age of Child, Mos.	No. of Child	Sample	Amt. in c.c.	Sp. Gr.	Total Solids	Fat	Sugar by		Protein			Ash
									Reduction	Difference	Total	Casein	Albumin	
29	31	10	4	Individual, 4 days	450	.....	12.25	3.02	7.92	8.02	1.00	.30	.70	....
30	25	10½	1	Individual, 2 days	465	1.031	12.29	3.24	7.58	8.00	0.84	...	...	.2148
31	23	11¼	1	Individual, 2 days	480	1.036	10.00	0.97	....	7.77	1.05	...	...	.2107
32	33	12	3	Individual, 3 days	350	1.031	12.16	2.43	7.65	8.36	1.15	.35	.80	.2141
33	30	12½	4	Individual, ½ day	650	1.032	12.38	3.71	7.57	7.58	0.92	.40	.52	.1728
34	26	12½	..	Individual, 1 day	690	1.028	12.77	3.87	7.01	7.66	1.03	.42	.61	.2108
35	..	14	..	Individual, 3 days	560	.....	10.63	2.00	7.14	7.31	1.14	.05	1.09	.1790
36	30	15	4	Individual, ½ day	640	1.029	15.56	6.20	7.10	8.00	1.20	.64	.56	.1675
37	..	18	..	Individual, 5 days	615	1.030	12.30	3.51	7.47	7.40	1.17	...	...	.2251
38	35	20	6	Individual, 3 days	690	1.033	11.44	2.70	7.77	7.34	1.22	.16	1.06	.1855

Transition.—In the transition period there is noted a striking reduction both in protein and total ash; but a considerable rise in the fat. Here again the percentage of fat in one specimen (No. 7) was so low as clearly to be an exceptional individual variation. The average for the remaining one individual and three composite samples was 4.37 per cent. The average values for the other elements were sugar 7.74; protein, 1.56; ash, 0.2581 and total solids, 13.39 per cent.

While these figures are too few in number to be regarded as more than suggestive, they indicate that the secretion of woman's milk is richer in fat, in protein, in salts and in total solids in the early weeks of lactation than at a later period. It corresponds also to the needs of the infant during the period of his most rapid growth. This, as one would expect, is most striking in the case of the ash and the protein.

Mature.—The figures for mature milk are from seventeen large individual samples—usually the twenty-four hours' secretion. Though the number of cases is small, the figures have a value which does not attach to those obtained from a study of small samples. They were all from healthy women whose infants were thriving; they were all upon a mixed diet. The age and the number of the child are given in the table. As would be expected, the figures show considerable indi-

vidual variation in all the elements; this is least in the protein and greatest in the fat. The figures for sugar are given both as obtained directly by reduction and as estimated, in the more common way, by difference. Compared with the early or transition period there is noted a fall in the total solids which affects all the elements except the sugar, but is most noteworthy in the protein and the ash.

For comparison we at first divided these into two groups: the first group of nine samples of one to four months' milk; the second of eight samples of four to nine months' milk. But the differences in the individual samples and in the averages of these two periods was so slight that a separate grouping seemed unnecessary.

The individual variations in this period are most marked in the fat, the range being from 1.67 to 5.48 per cent. The smallest variation is seen in the sugar. The lowest value found was 5.54 per cent. Except for this one specimen the range was between 7.05 and 8.38 per cent. obtained by reduction, and 7.11 and 8.36 per cent. by difference. In the main, therefore, the values obtained for sugar by the two methods do not differ greatly. The range for the total protein is from 0.88 to 1.5 per cent.; the figures in all but three of the seventeen samples fall between 1 and 1.3 per cent. The relation of the casein and albumin continues fairly uniform throughout both periods. The range in the total ash is between 0.1590 and 0.2433 per cent., but the greater number of the samples fall between 0.18 and 0.22 per cent.

In the colostrum period the relation of the ash to total protein is 1:7; in the transition period it is 1:6; throughout the mature period it is about 1:5, or the same ratio as exists in cow's milk.

Late.—Greater interest attaches to a study of the ten samples of late milk—tenth to twentieth month, for so few observations on milk of this period have been published. There are two or three exceptional findings, but as a group the milks for this period show no constant or essential differences in any of their constituents from those of the mature period. The marked fall in the protein and ash noted by some observers was not regularly seen in our cases. In but two of the ten cases was the protein low, while in five of the ten cases the ash was higher than the average of the mature period.

Excluding the three very exceptional individual variations mentioned, two of fat and one in total ash, occurring in the colostrum and transition periods, the average percentage composition of the milk for each of the different periods is as shown in Table 2.

We have brought together in Table 3 the results of the analyses found in medical literature which bear on the composition of the ash of normal woman's milk. The cases have been grouped according to the division of Schloss to whose work we are much indebted. The total number of analyses we have been able to collect is but twenty-eight, even though we include five which are either incomplete or open to some question.

The results of our own observations on the different salts which make up the ash are given in Table 4, classified according to periods.

The variations in the total ash for the different periods have already been considered. The striking fall in the ash value continues only from the colostrum through the transition period; after this little regular variation is shown by these figures. In the samples in which the total ash was exceptionally low, while there was a reduction in all the ash constituents, it was most marked in the Na_2O and K_2O.

TABLE 2.—PERCENTAGE COMPOSITION OF WOMAN'S MILK BY PERIODS

Period	No. of Analyses	Fat	Sugar	Protein	Casein	Albumin	Ash	Total Solids
Colostrum, (1-12 da.).....	5	2.83	7.59	2.25	....	....	.3077	13.42
Transition, (12-30 da.).....	6	4.37	7.74	1.56	....	....	.2407	13.39
Mature, (1-9 mos.).....	17	3.26	7.50	1.15	.43	.72	.2062	12.16
Late, (10-20 mos.).....	10	3.16	7.47	1.07	.32	.75	.1978	12.18

Of all the ash constituents the percentage of CaO continues most nearly constant throughout. This is shown not only by periods but by individual samples. In only two of the entire thirty-eight samples analyzed did the value for this element differ very widely from the average. Both these (Nos. 15 and 17) were individual samples of three months' milk; these two represent the range of values found, viz., 0.0295 and 0.0702 per cent.

The figures for MgO show a wider variation, not only for the different periods, but in the individual samples. The fall from the highest value in the colostrum period to the lowest in the transition period is without evident explanation. The lowest value, 0.0036 per cent., was in an individual sample of transition milk (No. 10), the highest, 0.0161, was in an individual sample in the colostrum period (No. 4).

TABLE 3.—Distribution of the Ash—Grams Per 100 c.c. of Milk

A. COLOSTRUM PERIOD

No.	Author	Age of Woman, Yrs.	Age of Child, Days	Sample	Amt. in c.c.	Total Ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl	Percentage Composition of the Ash					
													CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
1	Söldner.....	..	5-8	Composite, 2 women	.....	.3497	.0330	.0068	.0330	.0470	.1370	.0710	9.4	1.9	9.6	13.6	39.1	20.4
2	Söldner.....	..	5-9	Composite, 6 women	.....	.2894	.0400	.0052	.0330	.0280	.1000	.0660	13.8	1.8	11.6	9.8	34.6	22.2
3	Söldner.....	..	5-9	Composite, 6 women	.....	.3382	.0420	.0077	.0280	.0670	.0870	.0920	12.6	1.4	8.4	19.9	25.9	27.1
4	De Lange*...	..	4-10	Composite, 10 women	.....	.....	.....	.....	.....	.0950	.0640	.....	....	...	....	....	....	....
	De Lange....	..	4-10	Composite, 23 women	.....	.....	.0410	.0090	.0580	.....	.....	.0680	....	...	....	....	....	....
5	Schloss.....	22	11-13	Individual.	.....	.3048	.0335	.0069	.0380	.0532	.0795	.0892	11.0	2.2	12.4	17.4	26.0	29.2
6	Birk†.....	..	.....	.....	.....	.2814	.0360	.0093	.1137	.0544	.0770	.....	12.7	3.3	40.4	19.3	27.3	....
				Averages...	.....	.3127	.0375	.0074	.0380	.0574	.0907	.0772	11.9	2.1	10.5	16.0	30.5	24.7

B. TRANSITION PERIOD

7	Söldner.....	..	7-12	Composite, (of several women)	.....	.2620	.0350	.0050	.0330	.0360	.0790	.0570	13.5	1.7	12.7	13.7	30.1	21.8
8	Söldner.....	..	22-63	Composite, (of several women)	.....	.2185	.0410	.0044	.0320	.0170	.0680	.0360	18.9	2.0	14.5	7.9	31.1	16.3
9	Schloss.....	22	14-17	Individual	760	.2331	.0400	.0069	.0393	.0338	.0678	.0425	17.1	2.9	16.8	14.4	29.0	18.2
10	Schloss.....	22	26	Individual	1,180	.1904	.0355	.0081	.0393	.0192	.0558	.0310	18.6	4.2	20.6	10.1	28.9	16.2
11	Bunge.....	..	15	Individual	.....	.2219	.0328	.0064	.0473	.0232	.0780	.0438	14.7	2.9	21.3	10.4	35.1	19.7
12	Bunge.....	..	18	Individual (same)	.....	.2187	.0343	.0065	.0469	.0257	.0703	.0445	15.6	2.9	21.4	11.8	32.1	20.3
				Averages...	.....	.2241	.0364	.0062	.0396	.0258	.0698	0.424	16.4	2.7	17.9	11.3	31.0	18.7

C. MATURE PERIOD

			Mos.															
13	Abderhalden	..	2-3	.....	.....	.....	.0489	.0065	.0585	.0253	.0795	.0468	19.1	2.5	22.9	9.9	31.2	18.3
14	Schloss.....	21	2⅓	Individual	2,000	.1886	.0387	.0094	.0431	.0219	.0522	.0255	20.5	4.9	22.8	11.6	27.6	13.3
15	Schloss.....	27	3	Individual	790	.2454	.0567	.0116	.0501	.0260	.0650	.0425	23.1	4.7	20.4	8.1	26.4	17.3
16	Schloss.....	19	3½	Individual	1,360	.1848	.0370	.0100	.0342	.0192	.0549	.0308	20.0	5.4	18.5	10.3	29.7	16.7
17	Schloss.....	27	4½	Indivldual	1,680	.2088	.0455	.0087	.0416	.0210	.0608	.0411	21.8	4.1	19.9	10.0	29.1	19.7
18	Schloss.....	..	.....	Composite	.....	.1913	.0386	.0076	.0447	.0162	.0529	.....	20.1	3.9	23.3	8.4	27.6	....
19	Schloss.....	..	.....	Composite	.....	.1838	.0380	.0073	.0383	.0196	.0536	.0312	20.7	3.9	20.8	10.6	29.1	16.9
20	Söldner.....	..	3½	Individual	.....	.1790	.0350	.0060	.0260	.0180	.0590	.0330	19.4	3.5	14.4	10.1	32.8	18.3
21	Blauberg....	..	.....	.....	.....	.1988‡	.0394	.0068	.0294	.0049	.0690	.0294	19.8	3.4	14.7	2.4	34.7	14.7
22	Pelka.....	..	.....	Composite	.....	.1828	.0474	.....	.0387	.0258	.0848	.0294	25.9	...	21.1	14.1	46.3	16.0
23	Pelka.....	..	.....	Composite	.....	.2484	.0328	.....	.0450	.0165	.0643	.0244	13.2	...	18.1	6.6	25.9	9.8
24	Backhaus and Cronheim	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17.4	3.2	14.8	7.9	33.7	15.5
25	Backhaus and Cronheim	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.5	2.1	11.8	15.9	27.3	23.9
				Averages...	.....	.1955	.0416	.0082	.0409	.0189	.0632	.0340	19.5	3.7	18.5	10.3	30.7	17.5

D. LATE PERIOD

26	Schloss.....	21	11	Individual	1,650	.1476	.0285	.0073	.0349	.0177	.0440	.0028	19.3	4.9	23.6	12.3	29.8	15.4
27	Schloss.....	..	11½	Individual	720	.1508	.0305	.0073	.0376	.0156	.0449	.0255	20.2	4.8	24.9	10.4	29.8	16.9
28	Schloss.....	26	14½	Individual	1,075	.1552	.0280	.0082	.0431	.0162	.0465	.0251	28.0	3.9	27.7	10.4	29.9	16.1
				Averages...	.....	.1512	.0290	.0069	.0385	.0165	.0451	.0211	22.5	4.4	25.4	11.0	29.8	16.1

* De Lange's work is usually quoted as a single, complete analysis. The original publication shows that part of the ash was determined from one sample, and the other elements from a second.

† Birk's figures are often quoted and hence are introduced. His value for P_2O_5 differs so widely from other published figures, as well as ours, that we have omitted this case in computing the averages.

‡ By addition, the figure by determination is not given in the original paper.

TABLE 4.—Distribution of the Ash—Grams Per 100 c.c. of Milk

A. COLOSTRUM PERIOD

No.	Age of Woman, Yrs.	Age of Child, Days	No. of Child	Sample	Total Ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
1	19-21	3-4	....	Composite, 5 women	.2960	.0431	.0092	.0308	*	*	.0640
2	18-25	3-5	....	Composite, 6 women	.3312	.0527	.0053	.0369	.0453	.0938	.0744
3	.....	5-7	....	Individual	.1747	.0476	.0076	.0526	*	*	.0304
4	.....	5-8	....	Individual	.2921	.0415	.0161	.0501	*	*	.0693
5	20-25	5-12	....	Composite, 4 women	.3117	.0382	.0125	.0347	*	*	.0462

B. TRANSITION PERIOD

6	16-21	12-30	....	Composite, 4 women	.2335	.0450	.0071	.0497	*	*	.0590
7	32	14	....	Individual	.2132	.0338	.0049	.0308	*	*	.0639
8	20	15-18	....	Composite, 2 women	.2471	.0437	.0073	.0370	.0392	.0585	.0598
9	19-32	14-28	....	Composite, 5 women	.3042	.0498	.0067	.0597	*	*	.0955
10	18	21	....	Individual	.2262	.0389	.0036	.0419	.0136	.0811	.0368
11	19	21	....	Individual, 24 hours	.2204	.0343	.0051	.0433	.0239	.0731	.0334

C. MATURE PERIOD

		Mos.									
12	18	1	1	Individual, 48 hours	.1825	.0413	.0052	.0265	.0183	.0480	.0251
13	32	2	2	Individual, 24 hours	.2200	.0497	.0092	.0276	.0131	.0638	.0423
14	24	2	3	Individual, 24 hours	.1902	.0414	.0084	.0317	.0148	.0502	.0364
15	26	3	2	Individual, 36 hours	.1717	.0295	.0057	.0239	.0214	.0494	.0352
16	25	3	2	Individual, 24 hours	.2127	.0459	.....	.0431	*	*	.0383
17	23	3	1	Individual, 24 hours	.2135	.0702	.0089	.0409	.0145	.0366	.0378
18	32	3	2	Individual, 24 hours	.2254	.0536	.0106	.0392	.0143	.0618	.0313
19	27	3½	2	Individual, 24 hours	.2433	.0555	.0091	.0440	.0175	.0714	.0378
20	23	3¾	1	Individual, 24 hours	.1914	.0503	.0090	.0310	.0250	.0504	.0318
21	39	4	2	Individual, 24 hours	.2090	.0456	.0067	.0331	.0129	.0599	.0437
22	23	4	1	Individual, 24 hours	.2141	.0535	.0077	.0366	.0112	.0633	.0313
23	26	5	1	Individual, 24 hours	.2281	.0545	.0072	.0386	.0126	.0661	.0320
24	37	6	2	Individual, 48 hours	.1922	.0412	.0082	.0299	.0158	.0582	.0315
25	30	6	4	Individual, 36 hours	.1590	.0354	.0072	.0212	.0031	.0545	.0304
26	30	7	2	Individual, 24 hours	.2402	.0513	.0084	.0514	.0133	.0644	.0376
27	22	8½	1	Individual, 48 hours	.2158	.0430	.0092	.0380	.0169	.0688	.0444
28	38	9	1	Individual, 2 days	.1974	.0426	.0097	.0301	.0204	.0531	.0358

* The values for Na and K in the earlier samples have not been included in the table because the method of ashing the dried material, and later of igniting to drive off ammonium salts, was one in which a slight loss of Na and K by volatilization is possible. The Stolte method described elsewhere in the paper was used in the case of most of the other samples.

TABLE 4.—(*Continued*)

D. LATE PERIOD

No.	Age of Woman, Yrs.	Age of Child, Mos.	No. of Child	Sample	Total Ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
29	31	10	4	Individual, 4 days	.....	.....	.....	.0281	.0126	.0469	.0439
30	25	10½	1	Individual, 2 days	.2148	.0433	.0097	.0282	.0282	.0490	.0474
31	23	11¼	1	Individual, 2 days	.2107	.0483	.0045	.0348	.0133	.0594	.0405
32	33	12	3	Individual, 3 days	.2141	.0405	.0071	.0332	.0315	.0673	.0570
33	30	12½	4	Individual, ½ day	1728	.0390	.0059	.0227	.0188	0.504	.0339
34	26	12½	....	Individual, 1 day	.2108	.0320	.0072	.0297	.0338	.0551	.0521
35	..	14	....	Individual, 3 days	.1790	.0396	.0093	.0270	.0134	.0545	.0441
36	30	15	4	Individual, ½ day	.1675	.0348	.0093	.0296	.0146	.0556	.0301
37	..	18	....	Individual, 5 days	.2251	.0461	.0054	.0422	.0151	.0576	.0500
38	35	20	6	Individual, 3 days	.1855	.0280	.0048	.0284	.0135	.0794	.0433

AVERAGES FOR THE DIFFERENT PERIODS

	No. of Analyses	Total Ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
Colostrum (1-12 days).....	5	.3077	.0446	.0101	.0410	.0453	.0938	.0568
Transition (12-30 days).....	6	.2407	.0409	.0057	.0404	.0255	.0709	.0580
Early mature (1-4 months)..	9	.2056	.0486	.0082	.0342	.0154	.0539	.0351
Middle mature (4-9 months)	8	.2069	.0458	.0074	.0345	.0132	.0609	.0358
Late milk (10-20 months)....	10	.1978	.0390	.0070	.0304	.0195	.0575	.0442

The figures for P_2O_5 like those for CaO do not show wide variations either in the different periods or in the separate samples. The values are somewhat higher in the colostrum and transition periods; but they show no regular change till the late period when the smallest average is seen. The range is from 0.0526, an individual colostrum sample (No. 3) to 0.0212, an individual sample of a six months' milk (No. 25) in which also the total ash was the lowest met with in our observations.

For reasons already mentioned (see note to Table 4) we have reported only a single figure for Na_2O and K_2O in the colostrum period, and but three in the transition period. These figures indicate

TABLE 5.—Percentage Composition of the Ash

A. COLOSTRUM PERIOD

No.	Age of Woman, Yrs.	Age of Child, Days	No. of Child	Sample	Total Ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
1	19-21	3-4	....	Composite, 5 women	.2960	14.6	3.1	10.4	....	....	21.6
2	18-25	3-5	....	Composite	.3312	15.9	1.6	11.2	13.7	28.1	22.5
3	.....	5-7	....	Individual	.1747*	27.2	4.4	30.1	....	....	17.4
4	.....	5-8	....	Individual	.2921	14.2	5.5	17.2	....	....	23.7
5	20-25	5-12	....	Composite, 4 women	.3117	12.3	4.0	11.1	....	....	14.8

B. TRANSITION PERIOD

No.	Age of Woman, Yrs.	Age of Child, Days	No. of Child	Sample	Total Ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
6	16-21	12-30	....	Composite, 4 women	.2335	19.3	3.0	21.3	....	....	25.3
7	32	14	....	Individual,	.2132	15.9	2.3	14.4	....	....	30.0
8	20	15-18	....	Composite, 2 women	.2471	17.7	3.0	15.0	15.9	23.5	24.2
9	19-32	14-28	....	Composite, 5 women	.3042	16.4	2.2	13.1	....	....	31.4
10	18	21	....	Individual	.2262	17.2	1.6	18.5	6.0	35.8	16.3
11	19	21	....	Individual, 24 hours	.2204	15.6	2.3	19.6	10.8	33.2	15.1

C. MATURE PERIOD

No.	Age of Woman, Yrs.	Age of Child, Days	No. of Child	Sample	Total Ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
		Mos.									
12	18	1	1	Individual, 48 hours	.1825	22.6	2.8	14.5	10.0	26.3	13.8
13	32	2	2	Individual, 24 hours	.2200	22.6	4.2	12.6	6.0	29.0	19.0
14	24	2	3	Individual, 24 hours	.1902	21.8	4.4	16.7	7.8	26.4	19.2
15	26	3	2	Individual, 36 hours	.1717	17.2	3.3	13.9	12.5	28.8	20.5
16	25	3	2	Individual, 24 hours	.2127	21.6	1.3	20.2	....	31.9	18.0
17	23	3	1	Individual, 24 hours	.2135	32.9	4.2	19.2	6.8	17.1	17.7
18	32	3	2	Individual, 24 hours	.2254	23.8	4.7	17.4	6.3	27.4	13.9
19	27	3½	1	Individual, 24 hours	.2433	22.8	3.7	18.1	7.2	29.4	15.5
20	23	3¾	2	Individual, 24 hours	.1914	26.3	4.7	16.2	13.1	26.3	16.6
21	39	4	1	Individual, 24 hours	.2090	21.8	3.2	15.8	6.2	28.7	20.9
22	23	4	1	Individual, 24 hours	.2141	25.0	3.6	17.1	5.2	29.6	14.6
23	26	5	2	Individual, 24 hours	.2281	23.9	3.2	16.9	5.5	29.0	14.0
24	37	6	4	Individual, 48 hours	.1922	21.4	4.3	15.6	8.2	30.3	16.4
25	30	6	2	Individual, 36 hours	.1590	22.3	4.5	13.3	2.0	34.3	19.1
26	30	7	1	Individual, 24 hours	.2402	21.4	3.5	21.4	5.5	26.8	15.7
27	22	8½	1	Individual, 48 hours	.2158	19.9	4.3	17.6	7.8	31.8	20.6
28	28	9	....	Individual, 2 days	.1974	21.6	4.9	15.3	10.4	27.0	18.2

* This is so exceptional a figure that the values are excluded in computing the averages.

TABLE 5.—(*Continued*)

D. LATE PERIOD

No.	Age of Woman, Yrs.	Age of Child, Mos.	No. of Child	Sample	Total Ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
29	31	10	4	Individual, 4 days	†						
30	25	10½	1	Individual, 2 days	.2148	20.2	4.5	13.1	13.1	22.8	22.1
31	23	11¼	1	Individual, 2 days	.2107	22.9	2.1	16.5	6.3	28.2	19.2
32	33	12	3	Individual, 3 days	.2141	18.9	3.3	15.5	14.7	31.4	26.6
33	30	12½	4	Individual, ½ day	.1728	22.6	3.4	13.2	10.9	29.2	19.6
34	26	12½	....	Individual, 1 day	.2108	15.2	3.4	14.1	16.1	26.2	24.8
35	..	14	....	Individual, 3 days	.1790	22.1	5.2	15.1	7.5	30.4	24.6
36	30	15	4	Individual, ½ day	.1675	20.8	5.6	17.7	8.7	33.2	18.0
37	..	18	....	Individual, 5 days	.2251	20.4	2.4	18.8	6.7	25.6	22.2
38	35	20	6	Individual, 3 days	.1855	15.1	2.6	15.3	7.3	42.8	23.4

† Percentage could not be calculated as total ash was not determined.

AVERAGE PERCENTAGE COMPOSITION OF ASH FOR THE DIFFERENT PERIODS

	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
Colostrum	14.2	3.5	12.5	13.7	28.1	20.6
Transition	17.0	2.4	16.9	10.9	30.8	22.9
Mature	23.3	3.7	16.6	7.2	28.3	16.5
Late	19.8	3.6	15.5	10.1	28.8	22.3

the highest value for Na_2O in the colostrum period, next in the transition period, while during the early and latter part of the mature period it falls to less than one-third the amount. It is noteworthy that three of the ten late milks show a very high sodium figure; the figures for the other samples correspond with those of the mature period. The extreme individual variations of sodium are considerable in the mature period—from 0.0031 (No. 25) to 0.0250 (No. 20); but in the remaining cases of this period the value for this constituent is very close to the average.

Like Na_2O the value for K_2O is highest in the colostrum period and next in the transition period, but after this time it is quite uniform even in the late period. The individual variations are smaller than in the case of the sodium.

The figures for Cl vary much like the two constituents just mentioned; in all periods they bear a very close relation to the combined values of Na_2O and K_2O, indicating that it is combined as chlorids of sodium and potassium in the milk. The P_2O_5 and the CaO have also a close relationship in all periods, indicating their existence in milk as calcium phosphate.

Considering the milk by periods, we note that the high ash of the colostrum period is chiefly due to the higher values for Na_2O and K_2O; the values for CaO and P_2O_5 differing but slightly from those of the later periods. The values of the transition period show a further fall in Na_2O and K_2O and Cl, but little change in the other elements.

No constant or essential differences are seen in the values for the salts which make up the ash in either the early or latter part of the mature period, nor, in fact, even in the late period. These were grouped separately for the purpose of determining whether such a difference existed. Even in the late period the values show very little difference from those in the preceding period.

Some details of the women furnishing the late milks are interesting. In four instances (Nos. 29, 33, 34 and 36) the supply was still abundant and nursing was being carried on successfully (Nos. 33 and 36 were from the same woman). Three samples (Nos 30, 35, 38) were taken at the very end of a previously successful lactation, two or three days' pumping being usually required to obtain sufficient milk for analysis. In three cases (Nos. 31, 32, 37) there was still a good supply of milk, the infants being partly nursed and partly fed.

From a practical standpoint the best idea of the salts of woman's milk is obtained from a study of the percentage composition of the ash. This is given in the Table 5.

A comparison of the percentage composition of the salts of woman's milk, mature period, with those of cow's milk is highly instructive. The figures for cow's milk are the averages of nine analyses of our own, made of milk from mixed herds.

The close correspondence between these figures is very striking. In all the constituents except P_2O_5 the percentages of the different salts in the two milks are practically the same. The higher proportion of phosphorus in cow's milk is due to the large amount in the casein. Though the *proportions* of the different salts of the ash in cow's milk are so nearly those of woman's milk, the *amount* in cow's milk is about three and a half times as great. Unless, therefore, cow's milk has

been diluted with more than twice its volume, the amount of these inorganic constituents furnished to the infant is equal to that which he receives in woman's milk. The addition of lime or other inorganic salts to cow's milk because they are lacking in amount is therefore quite unnecessary in infant feeding.

A general comparison of the results of our analyses with those of the other authors cited shows a general agreement in most of the essential points. There is, however, less variation between the findings in our individual cases than between the findings of the different investigators who have made but a small number of analyses. It is not unlikely that differences in methods or in technic may be responsi-

TABLE 6.—COMPARISON OF THE PERCENTAGE COMPOSITION OF THE ASH OF WOMAN'S AND COW'S MILK

	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
Mature woman's milk	23.3	3.7	16.6	7.2	28.3	16.5
Cow's milk	23.5	2.8	26.5	7.2	24.9	13.6

ble, in part, at least, for some of these wider variations. We feel that enough analyses of the salts of normal woman's milk have now been made to afford a basis for comparison with abnormal milks studied in connection with metabolism observations.

There remains for brief discussion a consideration of the iron content of milk. For reasons already given, we have not undertaken a study of this part of the subject. The results of the analyses of the authors quoted in the earlier part of the paper indicate that the figures previously given for iron are too high; that woman's milk contains but 1.7 mg. of iron in a liter, while cow's milk has barely one-third as much —really a negligible quantity. By these figures iron forms but 0.00007 per cent. of the ash of cow's milk, and 0.00015 per cent. of the ash of woman's milk.

SUMMARY

1. The use of large individual samples of milk for analyses has advantages not offered by such small ones as have been commonly employed. For a determination of the inorganic constituents large samples are indispensable.

2. In the colostrum period woman's milk has high protein and high ash with rather low fat; in the transition period the protein and ash are lower while the fat is higher; in the mature period (after one month) the composition of normal milk does not vary in any essential or constant way quite up to the end of lactation. The only striking feature of late milk is a decline in quantity, though there is noted a slight fall in all the solid constituents except the sugar.

3. Of the different constituents of milk the least variation both in individuals and in periods is seen in the sugar. The proportion of this is somewhat higher than the generally accepted 7 per cent.; 7.5 per cent. is nearer the correct figure.

4. The greatest individual variations are seen in the fat, though the period variations in fat are not marked.

5. The protein is highest in the colostrum period and falls to a little over half the proportion in mature milk, during which period it is seldom over 1.25 per cent.; of this about one-third is casein, and two-thirds lactalbumin.

6. The high ash of the colostrum period is chiefly due to the amount of Na_2O and K_2O. Of the salts which make up the ash, the greatest individual, as well as the greatest period, variations are seen in the Na_2O; the least individual and period variations are seen in the CaO, the proportion of which is nearly constant throughout the period of lactation.

7. The largest constituent of the ash of woman's milk is K_2O; this with the CaO together make up more than half the total ash.

8. Although in amount the total ash of cow's milk is about three and one-half times as great as that of woman's milk, the proportion of different salts which make up the ash is nearly the same, the only exceptions being that cow's milk has more P_2O_5 and less iron.

We desire to express our thanks to those who have assisted us in obtaining specimens of milk for examination; especially to Dr. Herman Schwarz, Prof. J. Clifton Edgar, Dr. F. C. Freed and to the House Staff of the New York Found ling Hospital.

DISCUSSION

DR. GERSTENBERGER: I should like to know what the iron determinations were, if these were made. Bahrdt and Edelstein found that cows' milk had decidedly less iron than breast milk.

DR. SOUTHWORTH: One of the interesting things about the table is the high fat in the transitional period, the highest of any of the estimations. This is the time when we are so frequently confronted with the bad effects of high

fat in maternal milk, and get the gastric disturbances and vomiting that come from the infant's getting milk too high in fat. This can frequently be overcome by diluting the breast milk with barley water or some alkaline solution. The fact that the breast milk is normally high in fat at that time, and then shows a tendency to fall, gives an explanation of the fact that if we are temporarily able to overcome the effects of the high fat by diluting the breast milk, nature will come to our assistance later in lowering the amount of fat.

DR. HOLT: We have made no determinations of the iron of the milk, because, for this alone it is necessary to use such large quantities as to preclude other determinations. The iron determinations in milk made with very small samples, often only 30 c.c., are untrustworthy.

A PLEA FOR ACCURATE STATISTICS IN INFANTS' INSTITUTIONS

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In a Report on the Mortality in Foundling Institutions read at the last meeting of the American Association for Study and Prevention of Infant Mortality,[1] it is correctly stated that the gravity of this problem cannot be given in exact terms. Practically no one knows how many infants pass through these institutions each year, whence and how they come, or whither they go at the end of their stay. "How many die, and how many of those who live lead lives of suffering and impaired usefulness, and possibly of dependency and crime, through the action of causes which might be prevented, and how these preventable causes may be removed—these are the questions for which answers must be sought."

The problem is here very well stated and no question of greater importance can come before a body of pediatricians for discussion and attempted settlement. The first essential preliminary is a full knowledge of all the facts which, at present, are unknown. This points to the necessity for a collection of accurate data to precede any efforts toward permanent improvement in methods. If a close cooperation can be established between physicians working in this special field and the institutions covering it, much may be accomplished in mapping out a program that can attempt to conserve the good and do away with the evils that have grown up around this work.

That the operation of these institutions leaves much to be desired is known to all who are engaged in this work. This is not intended to impugn motives, as much unselfish effort and poorly requited labor is given in them. The time has come, however, to see if all this energy is expended in the wisest way, and, if not, how the methods may be improved. Enough is now known to indicate that some change of methods is desirable.

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11. Mortality in So-Called Foundling Institutions. Trans. Fifth Annual Meeting. American Association for Study and Prevention of Infant Mortality. 1914.

In the report previously mentioned, the New York State Department of Charities is quoted as presenting the statistics from 1909 to 1913 of eleven institutions in the state in which the death rate for babies under two years, during this period, based on the total number of children cared for, varied in the different institutions from 183 to 576 per 1,000, with an average mortality rate for the eleven of 422.5 per 1,000. During these same years the death rate for children under two years, based on the estimated population for the state at that age, was 87.4 per 1,000, or about one-fifth of that in institutions. Again, in studying a series of 1,738 institutional infants admitted at various ages under one year, 22.7 per cent. of all admitted died before completing the first month of residence, and 34.9 per cent. before completing the second month. Including all deaths, 44.3 per cent. occurred in less than one month after admission, and 68.7 per cent. in less than two months.[1]

In a recent article the writer reported a study of the mortality in ten infant asylums located in different cities of the United States.[2] The time covered varied from four to twenty years, taking the shortest and longest intervals. The rates were based on the ratio between yearly admissions and deaths and were as follows: 53.17 per cent.; 40.6 per cent.; 40 per cent.; 60 per cent.; 31.7 per cent.; 75 per cent.; 65.8 per cent.; 47.7 per cent.; 36.1 per cent.; 49.5 per cent. In all but one of these institutions deaths included all infants under two years. The ages of the deaths were not given in the reports, but as the greatest mortality is especially under one year, the showing would be worse if restricted to this age limit.

Drs. Holsclaw and Rude of San Francisco report the mortality in the foundling asylums of that city as 50 per cent.[3] On boarding out babies with foster mothers in order to insure undivided care, the mortality in the same class of cases has been reduced to 12 per cent.

According to Woodward, death rates, general and special, and morbidity rates must be relied upon to show where and how sanitary work is needed and to exhibit the results of sanitary work already

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2. Chapin, Henry Dwight: Are Institutions for Infants Necessary? Jour. Am. Med. Assn., Jan. 2, 1915.

3. Holsclaw and Rude: Morbidity and Mortality of the Associated Charities Feeding Clinic, San Francisco, Arch. Pediat., March, 1915.

under way.[4] The same can be said in reference to institutional methods of work with any class in the community. It is hence exceedingly important to have accurate knowledge of all possible data as to morbidity and deaths that may throw light upon the results of methods of operation either accomplished or under way.

In order to secure such knowledge certain specific facts should be given, which a search into all the institutional reports that have been accessible to the writer shows to be rarely stated or properly analyzed. The information given in these reports is, in most cases, meager and unsatisfactory. All facts that can present a fair picture of the health and hygienic condition of an institution should be carefully presented. Special care should be taken in keeping records of babies under one year. The individual study of each baby should include the history on admission, age, physical condition, length, weight, general nutrition, previous feedings, history and record of antecedent diseases. The babies should be classified or graded by ages on admission as to physical condition, weight, length and nourishment. Summaries could then be made showing the average gain or loss under each heading. If there is gain, a comparison can then be made with that of the non-institutional baby. There should also be kept a record of the diseases acquired or contracted during the babies' stay in the institution. The summaries of the individual records should show the number of cases of each disease, of communicable diseases and mixed infections, and these diseases classified as to their preventability. Each epidemic should be traced to its source. The final summaries should show the average age on admission, the average length of stay of those who live and those who die, together with the total number of admissions and discharges. It would also be of interest to have a proper "follow up" system which could show, among other data, how many of those discharged before one year of age live to be a year old. It is doubtful if many physicians on the staffs of various institutions can give accurate data along these lines as to the conditions and results of their work.

DISCUSSION

DR. HAMILL: I am very glad that Dr. Chapin has brought the subject before the society. The mortality of these institutions has been well shown by his own investigations and the investigations made in New York, to be enormously

4. Woodward, William C.: The Practical Application of Vital Statistics, American Statistical Journal, December, 1907.

high, but I do not think that any of the statistics that have been collected up to the present show the actual mortality among infants admitted to institutions and kept in them. The mortality is largely based on the number of infants kept in the institutions together with those boarded out.

I had the honor to be connected with an institution in Philadelphia in which the mortality among all infants under 1 year when admitted to the institution and retained there until the time of death, was 100 per cent. That is, no infant admitted under 1 year of age lived to be 2 years old. If, however, anyone should search in the report of that institution, he would find nothing in it touching on the morbidity or mortality in the institution. Recently, at a public dinner, the mortality among the infants of that institution was announced to be 10.8 per cent. The institution has a medical staff that never visits it, and a resident physician who practices on the outside. These institutions exist in our cities without arousing any protest on the part of the medical profession. Some one is responsible for this condition of affairs, and the responsibility should rest on the medical profession. We should do everything in our power to correct these conditions.

DR. PORTER: I should like to speak of the work done by Drs. Holsclaw and Rude in the Associated Charities Baby Clinic, San Francisco. The striking thing about it is that the year before boarding out was begun the mortality there was 56 per cent.; but that during the last year, the mortality among that particular group of infants was less than 3 per cent. That is the best infant mortality record in this country. The reason for this low rate lies in the fact that these children are especially followed. The nurses visit them constantly. Every child that is boarded out is seen by the nurse at least once a week: and by the physician once a month. Furthermore, they have other visiting physicians who have been good enough to volunteer their services; and emergency calls are made by these physicians within a few hours, at the most, after the call is received. Moreover, the foster mothers are so disciplined that if they do not call a physician, but try to doctor the infants themselves, they lose their babies promptly; and they get so fond of the children that there is no trouble with that group of women. That is the whole secret of successful boarding out, to get the foster mothers disciplined. It is not easy, unless you have enthusiastic medical men and women like those in San Francisco.

DR. VAN INGEN: There are one or two points in the statements made by Dr. Chapin based on these figures for New York City, which I think emphasize the need of careful study of the whole problem of the care given to babies in institutions. Among these 1,738 babies Dr. Chapin stated that 22 per cent. of all that died, died within one month of their admission to the institution. On the other hand, the mortality among those babies who were born in the institutions was only 8 per cent. during the first month of life, but before the year was over, 48 per cent. had died. These babies were born of mothers admitted to the hospital several months before confinement and, although the mortality during the first month of life is normally high, there were only 8 per cent. of these babies who died during this period. When, after the first month of life, an additional 40 per cent. died before the end of the first year, it would seem as if institutional environment must play some part in producing this result.

DR. SOUTHWORTH: I am thoroughly in accord with Dr. Chapin's efforts to improve the conditions in institutions for infants. It would be of extreme value, I think, if we could get the statistics that Dr. Chapin has outlined; but

I do not feel very hopeful that he would be able to get such accurate statistics as he desires. I can give an instance of this difficulty from an institution that no longer exists, in which on account of the very considerable mortality among the infants admitted it was customary to enter the condition of every infant on its admission card as "hopeless." That covered all subsequent happenings.

DR. KNOX: I can give testimony from Baltimore of the same kind. A year or two ago I had occasion to investigate the foundling babies sent to the different institutions by the city supervisors. Over two hundred were admitted and all were followed by the secretary of the supervisors. Within a year after the handing over of these babies to various institutions, between 89 and 90 per cent. of them had died. The 10 per cent. that lived, did so, apparently, because, for some reason or other, the babies had been taken from the institutions for short times and given into the care of foster mothers or relatives. None of those that stayed continuously in the institutions lived to the end of the first year.

No subject can be brought to our attention that is more important than this. Either we must see that approximately normal care is provided in the institutions, or we must see to it that foster homes are provided for these babies. There is a great field for the development of foster homes for such infants. The infants should be well before being sent to foster homes. We have had no trouble in Baltimore in securing homes in which trained nurses may visit the children. The calling of a foster mother is an honorable one for women who can make a living only with difficulty in other ways. A great many that are suitable in character volunteer. By the more general use of supervised foster homes for crowded institutions the great mortality now pertaining to the foundling may be reduced.

DR. SHAW: I am glad that the subject of infant mortality in institutions has been brought before this Society, as there is no body of men more fitted to solve this great problem. It is very difficult to make a comparison between the infant mortality outside of institutions and that inside, because the infant mortality rate is generally reckoned on the ratio of one thousand living births. We cannot utilize this ratio in institutions as in a number of the institutions in New York City a large per cent. of sick babies are admitted for special care and treatment. When we compare the number of deaths with the number of admissions we are confronted with the fact that in some institutions only the admissions in each fiscal year are reckoned, while in others the number of infants remaining in the institution at the beginning of the fiscal year are included with the new admissions.

I have a feeling that conditions are improving, for not many years ago Dr. Jacobi stated that no baby lived more than three months in the Randall's Island institution. The State Charities Aid Association, in New York State, is making special efforts for the placing out of institutional children, and the homes of foster parents are being carefully inspected. It is hardly fair to compare the mortality of these "placed out children" with those left in the institutions, as only selected babies are given homes while the less fortunate and weakly are left in the institutions.

The fact remains that institutional mortality is high and that while the infant mortality outside of institutions is being remarkably diminished, that in the institutions still remains high. This is a problem for the pediatrician to solve.

DR. CHAPIN: Last year the President in his address stated that one function of the American Pediatric Society should be to deal with questions touching

the public at large. He was right. While valuable scientific work may be done by us, we should not neglect a broader field, in which public interests present themselves. A great deal of work has been done regarding infant mortality, but this one thing has been neglected—a factor that does more to increase infant mortality than any other aspect of the question. The milk supply has been improved, and other valuable hygienic work has been done, and yet these institutions with their heavy mortality still exist; and it is the doctors' fault.

With reference to the statistics given in this paper, I would say that I stated that it was difficult to get accurate statistics. The figures I have obtained were from the report on the mortality in the so-called foundling institutions published in the Transactions of the Association for the Study and Prevention of Infant Mortality. I did not say that they are absolutely accurate. I said that we want to get accurate statistics, but cannot get them. We know, however, that the mortality is double and treble what it ought to be; and we can prevent it, if we wish.

SOME STUDIES ON SUGAR IN INFANT FEEDING

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Some years ago Finkelstein[1] caught the attention of the world by formulating a new conception of the underlying causes of what were then considered diseases of gastro-intestinal origin. He described them as purely nutritional disturbances, divorced them from any relationship with the bacterial invaders of the intestine, and laid the blame of their genesis on an element of diet that had heretofore been considered innocuous, namely, the sugar. Especially did he attribute that serious, acute form of infantile disease accompanied by stupor, mellituria, and fever to the sugars. The last two symptoms were, he taught, directly and proportionately due to its presence in the food. Later, he implicated the mineral salts of cows' milk, still later prepared his celebrated "Eiweissmilch" and offered it as a remedial food for sugar intoxications, apparently overlooking the fact that as this mixture contained 1.5 per cent. of the deadly lactose its use in practice contradicted his theory. Lactose was especially the sugar he feared, so much so that he stated that even minute doses of milk containing its natural carbohydrate were damaging. Babies were injured with lactose, dextrose, lactose salt mixtures, and dextrose alkali or lactose alkali mixtures, given in isotonic, hypertonic, or hypotonic proportions. The injury was considered always to express itself in mellituria and fever, and F. M. Schapps, Leopold and Von Reuss were one in thinking with Finkelstein that lactose was "exquisitely pyrogenic." This point was emphasized by the findings of Finkelstein and Meyer that 3 gm. of sodium chlorid in 100 c.c. of water given by mouth could produce fever in many healthy infants, while if nutritional disorders were present 1 gm. sufficed to produce pyrexia.

In the next few years the men of this school decided that sugar damage was not alone a simple sugar injury, but made itself felt as the result of the previous or coincident action of salts in improper

proportions in the food, the presence of the chlorin ion combination with sodium being especially blamed. About four years ago the idea that fermentation of sugar in the intestine played some rôle in these disorders began to be emphasized in Finkelstein's writings, and Finkelstein and Meyer laid greater stress on the fermentation of lactose in the intestine and less on the toxicity of sugar acting parenterally. They even admitted that human milk, which of course is high in lactose, may be the optimum food for certain of the cases that occurred under their classification of intoxication, apparently thus abandoning the view that milk sugar is a fatal poison in such disorders. This inference from the writings of Finkelstein is confirmed by his pupil Schultz, whose experiments did not bear out the pyrogenic or intoxicating action of the sugars. The latest position of Finkelstein's school seems to be that fermenting lactose injures the permeability of the intestinal wall, permits the absorption of salts in abnormal kind or quantity, and that these salts, either alone or in combination with the sugar, produce the poisoning which is evidenced by the glycosuria.

As to fever, there was some reason to believe that when it occurs it is the result of tissue damage such as is often seen following injections of sterile water or salt solution when they break up the erythrocytes, analogous to the fever not at all infrequently seen in childhood that follows extensive bruising or the production of hematomata.

The most convincing work among the group of men that oppose the Finkelstein-Langstein view was done by Allen working in Rosenau's laboratory. In a long series of experiments with animals in the nursling stage the effects of sugars were tested when given both by mouth and subcutaneously. Experimental animals were used and the experiments ingeniously devised to meet all objections. The animals were given large doses and small doses, some were given repeated injections and some single large doses. Those animals which received their sugars by mouth, especially lactose, showed as effects vomiting and diarrhea, which undoubtedly were due to the fermentation of the sugars in the intestine. In no one of the animals was there any sign or symptom of an intoxicating action of sugar, nor was Allen able to produce any symptoms at all approaching the clinical picture of the sugar intoxications as outlined by the Germans. On the contrary, in spite of glycosuria, which occurred in all experimental animals, he was able to see that subcutaneous injections of glucose were very

definitely beneficial to his kittens and puppies, especially to one group that was weaned early and doing very badly. This seems a more rational finding than the view that implicates sugar as a poison to metabolism, as every one has seen the apparent benefit of glucose injections in the case of very sick babies.

The study of the literature would make it seem that the origin of the idea of sugar damage went back to Grosz, and was later elaborated by Langstein and Steinitz in a paper, "Lactase und Zucker Ausscheidung," published in 1906, which seems to have turned Finkelstein's interest toward the sugars as agents of possible damage in infantile nutritional disturbances. These authors in fourteen cases of severe gastro-intestinal disorders proved to their own satisfaction that a part at least of the sugar excreted into the urine was lactose. In five cases they found a second sugar which they believed to be galactose. They conclude that there can be no doubt that infants with severe gastro-intestinal disease excrete milk sugar, and its split-off product, galactose, in the urine, and that this excretion is independent of the excretion of lactase in the stool. They further say that in severe cases of gastro-intestinal disease only part of the milk sugar is split by lactase into dextrose and galactose. These are then burned in the organism or the galactose is excreted if the oxidizing power of the tissues has suffered. The second portion is absorbed unsplit and excreted as lactose in the urine. They admit that the largest proportion may be split by fermentation in the intestine and may be lost to the organism.

The views of Kendall are that lactose, far from being an injurious food, is of essential importance in so maintaining the flora of the intestine that the fermentative processes will always be slightly dominant, and will prevent the putrefactive action on protein which produces soluble toxin of undoubted damage to the general metabolism. The work of Allen and the paper of Kendall are both worthy of very close study by any one who is interested in the subject. Raphael showed that many patients assimilate large doses of sugar better than small ones. Schlessinger says that the appearance of the traces of sugar in the urine are no indication that the sugar tolerance of the body has been passed. Naunyn says that small traces of sugar may be ignored in animals who may show a slight glycosuria, with small doses and none with large. Platenze says sugar is often to be found in urine of babies who show no sign of intoxication and who seem perfectly well.

The dosage usually given for pure dextrose as one that will exceed the sugar tolerance is between 100 and 250 gm. for the adult, but many individuals can assimilate more. After the subcutaneous injection of 100 gm. of glucose, glycosuria may last as long as eight hours. The single dose maximum seems to be from 2 to 4 gm. per kilo, by mouth, 10 gm. per kilo per day, and subcutaneously 1 to 1.5 gm. per kilo per dose.

The presence of traces or of even considerable amounts of reducing bodies in the urine does not mean that sugar is present. Schultz says that a reduction test which will exclusively demonstrate the presence of sugar is not known, and further, reducing substances such as uric acid, creatinin, albumen, coloring matter, acetone, glycuronic acid, all or any may be present. Fluckiger reports the presence in normal adult urines of non-fermentable reducing bodies which produce osazones of a value equal to 1/1500 to 1/2500 gm. of grape sugar in the twenty-four hours. Salkowski put it at 0.4 gm., Monk at 0.3 gm., and other observers at variable points. Creatinin has especially been dealt with by Sedgwick, Steinitz, Fluckiger, Amberg and Morris, so that it is clear that in infants' urines there may be considerable reducing power due to bodies other than carbohydrates, a fact well substantiated for the normal urine of adults.

This fact, together with the report by the Finkelstein school of the frequent presence of sugars in the urines of infants suffering with a less severe nutritional disturbance, made it seem desirable to test the urine of a group of infants in the Boston Infants' Hospital, who were suffering from what would be known in Europe as "balance disturbance," but which in the nomenclature of the Boston school is called "chronic indigestion." There were eighteen of these babies investigated; none of them were of the premature type such as Aschenheim found to have intestines more permeable to sugar than those of older nurslings. The first tests were all made while the children were receiving what was considered a normal amount of sugar advisable for their individual peculiarities. Later, attempts were made on a number of the cases to find the limit of physiologic tolerance for the sugars. The reagent used in the determinations was one recommended by Folin as the most sensitive to reducing bodies. It was made in two solutions, of which 3.5 c.c. of each were mixed at the time of using and from 1 to 3 c.c. of the urine added after boiling the mixture.

The mixture was then centrifuged. Solution 1 contained copper sulphate 10 gm., glycerin 150 c.c., and water to make 500 c.c. Solution 2 contained 500 c.c. of a 50 per cent. solution of potassium carbonate. This reagent has shown definite amounts of reducing bodies in every adult urine tested with it. This is not true of infants' urines. Twelve per cent. showed no reduction whatever, and of the remainder, 50 per cent. gave no reduction on repetition of the test after saturation with picric acid and shaking through ten minutes to remove the creatinin which is present in appreciable quantities in nearly all infants' urines, and which reduces nearly all the copper reagents especially the more delicate. In none of the urines was it possible to measure the reduction quantitatively by Benedict's solution.

The fact having been determined that there was no measurable sugar in any of the urines tested, attempts were made to pass the sugar tolerance limit of 2 to 4 gm. per kilogram of body weight without the production of a measurable glycosuria. Such attempts have been made before and have always failed to cause a glycosuria except in those cases of deep intoxication such as were studied by Finkelstein and his pupils.

A summary of the work done in this investigation is as follows: Patients observed, 18; samples of urines tested, 105; number of tests made, 235; signs double + and triple + are used as follows: + indicates on the addition of the urine to the heated reagent a few grains of copper oxid; ++ indicates that on centrifuging definite layer of copper oxid forms in the bottom of the tube; +++ that there is a visible reduction in the tube before centrifuging. Sixteen of the eighteen patients showed reducing bodies in some tests before the treatment with picric acid. Eight showed a loss of reducing power after shaking with picric acid. Three of the patients (+++) showed appreciable amounts of reduction constantly in all samples of urine after the picric acid treatment. One of these had an eczema corresponding in type to the exudative diathesis of the Czerny school, but in spite of the fact that this patient received as much as 120 gm. of lactose, 15 per cent. of his intake per day while he was receiving 4 per cent. of fat at the same time, there was never enough sugar in the urine to be assured by any of the usual quantitative methods and coincidently the skin condition improved steadily under local treatment. The other two patients of this group were suffering from rather extreme malnutrition. Of the 105 samples of urine, 58 showed

reducing powers to our solution before shaking with picric acid. Of these 58, 27 lost their reducing power after such treatment. Of the eighteen patients, excepting the three referred to above, none showed reducing bodies every day, and in no instance did there seem to be any relation between the amounts of sugar ingested and the presence of these bodies as they were found in the urine with minimum intake, and were frequently absent following the highest ingestion.

The clinical results in these cases in which an effort was made to surpass the supposed limits of sugar tolerance were very interesting. Not knowing how severe the symptoms of intolerance might prove to be, we did not wish to give large doses of sugar suddenly, but adopted the method of a gradual increase in the amount of sugar given. The percentage of sugar in the food was increased at the rate of 0.5 per cent. a day until symptoms of intolerance developed. Lactose only was used in nine cases, dextrimaltose only in 1 case, and the tolerance for both lactose and dextrimaltose was tested in six cases.

None of the cases tested were of the severest type of malnutrition. One or two of the patients were babies having no gastro-intestinal disturbance. One presented a case of congenital obliteration of the bile ducts. The majority were babies who had presented difficult feeding cases in the Out-Patient Clinic, and had been sent in to the hospital to be straightened out. None showed any marked intolerance for any of the food elements. The majority were comparatively mild cases of fat intolerance, showing indigestion and excessive fat in the stools when the fat was increased. No case known to have a marked intolerance of carbohydrate was tried.

Symptoms of intolerance developed eventually in twelve of the sixteen cases. Three patients were taken home, and one patient died, before the experiment was completed.

The symptoms of intolerance were very constant. The first symptom, showing the coming on of intolerance, was marked irritation of the skin of the buttocks, in spite of the most careful nursing. The symptoms which soon followed were loose green movements, usually about five or six daily, distention of the abdomen with gas, eructations of gas, and vomiting. Loss of weight was slight; on the development of distinct signs of intolerance, the sugar was at once cut down. In no case were seen any toxic symptoms, or any signs of sugar intoxication, or any fever, except that one case developed fever at about the

time of the other signs of sugar intolerance, but at the same time this baby had an acute otitis media. The symptoms of sugar intolerance, therefore, judging from this series of cases, are in no way suggestive of intoxication, but are suggestive only of a fermental process localized within the intestinal canal.

The amount of carbohydrate taken without intolerance was surprising. The quantities of sugar given to the several cases are shown in the tables. Table 1 shows the maximum quantities of sugar taken

TABLE 1.—MAXIMUM SUGAR TAKEN WITHOUT SYMPTOMS

Case	Percent. in Food	Gm. in 24 Hours	Gm. in 24 Hrs. per Kg. of Body Weight	Gm. in a Single Feeding per kg. of Body Weight
1	Lactose, 9.5	91	9	2.25
2	Lactose, 7	83	20	3.00
3	Lactose, 14.5	169	31	4.75
4	Lactose, 14	119	40	4.00
5	Lactose, 11.5	134	28	4.00
6	Lactose, 15.5	144	32	4.40
7	Lactose, 8.5	79	18	3.00
7	Maltose, 9.5	91	20	3.00
8	Lactose, 15.5	168	27	4.50
9	Lactose, 5	53	10	2.00
9	Maltose, 12.5	158	27	4.50
10	Lactose, 7.5	67	24	2.00
11	Lactose, 8.5	100	20	3.00
11	Maltose, 8.5	100	20	3.00
12	Lactose, 12	160	17	3.00
13	Maltose, 11.5	119	33	3.10
14	Lactose, 10.5	140	30	3.00
14	Maltose, 18.5	170	54	5.40
15	Lactose, 11.5	150	18	3.00
15	Maltose, 17.5	225	27	4.50
16	Lactose, 13	146	22	3.10
16	Maltose, 18	182	30	4.00

without intolerance. These quantities were in general far above the supposed limit of 10 gm. daily per kilogram of body weight. The percentage of sugar taken without intolerance varied from 5 to 18.5 per cent., the grams in twenty-four hours varied from 53 to 225, the grams daily per kilogram of body weight varied from 9 to 54, and the grams of sugar at a feeding per kilogram of body weight varied from

2 to 5.40. The quantities on which intolerance eventually developed were slightly higher, and are shown in Table 2. Only one baby in the series showed inability to take more than 7 per cent. of sugar, or more than 10 gm. per kilogram of body weight in twenty-four hours.

In the six cases in which the comparative tolerance for maltose and lactose was tried, it was found to be about the same in two cases,

TABLE 2.—AMOUNT OF SUGAR ON WHICH SYMPTOMS OF INTOLERANCE DEVELOPED

Case	Percent. in Food	Gm. in 24 Hours	Gm. in 24 Hrs. per Kg. of Body Weight	Gm. in a Single Feeding per kg. of Body Weight
1 *	.....	...	...	...
2 †	.....	...	...	...
3	Lactose, 15	141	26	4.0
4	Lactose, 14.5	113	40	4.0
5	Lactose, 12	144	30	4.25
6	Lactose, 16	146	32	4.40
7	Lactose, 9	76	17	3.00
7	Maltose, 10	105	32	3.20
8 †	.....	...	...	...
9	Lactose, 6	53	10	2.00
9	Maltose, 13	150	26	4.60
10	Lactose, 8	72	26	2.00
11	Lactose, 9	105	20	3.00
11	Maltose, 9	105	20	3.00
12	Lactose, 12.5	172	18	3.00
13 †	.....	...	...	...
14	Lactose, 11	145	30	3.00
14	Maltose, 19	170	55	5.40
15	Lactose, 12	152	18	3.00
15	Maltose, 18	227	19	4.50
16	Lactose, 13.5	148	22	3.10
16	Maltose, 18.5	186	31	4.00

* Patient died before intolerance developed.

† Patient discharged before intolerance developed.

but distinctly higher for maltose than for lactose in the other four cases. In no case was there the slightest evidence of any relation between the amount of sugar given and the presence of a positive sugar test in the urine. The sugar was just as likely to be absent as present in cases taking a maximum of sugar, or in cases showing symptoms of intolerance. The three cases showing the constant pres-

TABLE 3.—Periods of Increased Sugar, Quantity of Sugar Taken, and Gain or Loss in Body Weight

Case	Food	Period of Increased Sugar (Days)	Percent. of Sugar in Food at Beginning of Period	Percent. of Sugar in Food at End of Period	Sugar in 24 Hours per kg. of Body Weight at Beginning of Period gm.	Sugar in 24 Hours per kg. of Body Weight at End of Period gm.	Gain or Loss in Body Weight During Period gm.	Average Daily Gain or Loss in Body Weight During Period gm.
1	Lactose	8	9.5	9.5	9	9	— 500	— 63
2	Lactose	13	7.0	7.0	20	20	+ 290	+ 22
3	Lactose	20	7.0	15.0	16	31	+ 780	+ 36
4	Lactose	18	7.0	14.5	22	40	+ 120	+ 7
5	Lactose	18	6.5	12.0	18	28	+ 330	+ 13
6	Lactose	20	6.5	16.0	14	32	+ 670	+ 33
7	Lactose	8	5.5	9.0	13	18	+ 220	+ 27
7	Maltose	10	6.0	10.0	14	20	+ 260	+ 26
8	Lactose	19	6.5	15.5	12	27	+ 1,000	+ 52
9	Maltose	16	6.0	13.0	14	27	+ 500	+ 31
10	Lactose	4	6.5	8.0	21	26	+ 120	+ 30
11	Lactose	7	7.0	9.0	16	20	+ 30	+ 4
11	Maltose	7	7.0	9.0	16	20	+ 90	+ 13
12	Lactose	13	6.5	12.5	9	18	+ 210	+ 16
13	Lactose	20	6.5	16.5	11	33	+ 1,000	+ 50
14	Lactose	7	7.0	10.5	20	30	+ 200	+ 27
14	Maltose	22	7.0	18.5	20	55	+ 680	+ 30
15	Lactose	10	6.5	11.5	9	18	+ 220	+ 22
15	Maltose	22	6.5	17.5	9	28	+ 790	+ 36
16	Lactose	13	6.5	13.0	14	28	+ 250	+ 19
16	Maltose	22	6.5	18.0	14	36	+ 580	+ 26

ence of sugar, showed the same reaction irrespective of the amount of sugar given. The other cases show positive and negative urinary tests at all stages. The last three cases, numbered 14, 15 and 16, showed sugar more often present with maltose than with lactose. Whether this is the rule requires further observation.

The effect of the increased quantity of sugar on the weight curves of the babies was most surprising, and is shown in Table 3. The majority of the cases not only gained weight, but gained weight very rapidly during the period of sugar increase. Also the gain, while less rapid after sugar intolerance developed and the sugar was cut down, was in all cases maintained. In some instances the gain was really enormous. Patients 8 and 13, both on lactose, gained 1,000 gm. in twenty days. Only one case, which afterward proved to be tuberculous, failed to gain. Excluding this case, the average daily gain for the whole series during the sugar period was 26 gm.

It seems to us that the idea of sugar injuries and sugar intoxication has possibly kept us from the use of large amounts of soluble carbohydrate in certain cases, particularly those unable to take a quantity of fat sufficient to meet their nutritive requirements. That many such babies have intolerance of sugar is indoubtedly true. But the danger of pushing the sugar to the limit of tolerance we believe to have been exaggerated. The signs of sugar indigestion are distinct and easily recognized, and do not appear to be in any way serious. In many cases great benefit appears to be obtainable by greatly increasing the carbohydrate content of the food, and therefore this proceeding may prove a valuable addition to our stock of resources in dealing with difficult feeding cases.

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DISCUSSION

DR. SCHLOSS: I wish to mention some results obtained by Dr. Perry and me which do not agree entirely with those just cited. We examined the urines of many infants for sugar and in the investigations used all of the available methods of identification. Some of the patients were normal, others suffered from various nutritional disorders. In a number of instances the urine reduced copper and bismuth salts to a slight degree, and yet by the more exact confirmative tests no sugar could be demonstrated. This may be due to the minute quantity of sugar, or may indicate that the reduction was caused by substances other than sugar.

In a number of urines from infants affected with nutritional disorders, we were able to demonstrate that the urine contained a reducing sugar. Contrary to the generally accepted view of Langstein and Steinitz and others, our results indicated that even though lactose was often present it was always accompanied by a monosaccharid—dextrose or galactose.

DR. PORTER: There is no antagonism between these findings mentioned by Dr. Schloss and the findings given in our paper, in which it was distinctly stated that the cases studied were merely ones of balance disturbance, and not of intoxication. In none was there any approach to the type of case in which, I think, Dr. Schloss most often got sugar.

This is merely a preliminary report. We have done some work, but not enough to permit us to speak with the authority that he does on the excretion of sugar in intoxications. We have done enough, however, to find that the work of Langstein and Steinitz is open to criticism and cannot be accepted as written.

The interesting thing to me in this work was the presence of reducing bodies other than sugar in such a large proportion of the urines of infants. As to the delicacy of the test used, the reagent is a copper, glycerin and sodium carbonate mixture, which is more delicately reactive to reducing bodies than any other reagent we have.

DR. ABT: There is one thing that occurs to me, and that is that in the evolution of alimentary intoxication as taught by Finkelstein and his school, he has, at various times, offered different explanations. The underlying thought that he and they had, however, is that sugar or any other food element finds its way into the circulation because there is a damaged intestinal wall. It is not damaged by the sugar, as I understand, or by any other food element, but by bacterial action, or some toxic product resulting from bacterial activity. When one speaks of food intolerance, whether it be fat, carbohydrate, protein or salts, for that matter, it simply means, according to Finkelstein, that these food elements break through the intestinal wall and find their way into the blood or the intermediary metabolism, and in this way do harm.

DR. HOLT: I should like to ask about the permanence of the gain in weight in Dr. Dunn's cases. It is not uncommon to have a rapid increase in weight for a time, perhaps on account of the water reduction; but in many cases with such high carbohydrates it is my observation that the break-down soon comes, and the infants lose weight quite as rapidly as they have gained. That a child may have intolerance to a small amount of sugar and yet tolerance to a large amount does not correspond with my experience. It is difficult to make a child with a great intolerance of carbohydrates gain weight. Lately, I have been using sugars more and more sparingly in the feeding of infants with intestinal disturbances. If protein milk is made by using half a liter of buttermilk to one liter of the protein milk there must be half as much sugar in the final product as in the buttermilk. Buttermilk contains on the average slightly over 4 per cent. of sugar so there must be at least 2 per cent. of sugar in the protein milk. This is confirmed by its analysis. So far as the total salts are concerned, they are much higher than in our usual milk modifications, almost as high as in whole milk. In preparing protein milk we adopt a procedure that he does not mention, twice washing the curd before it is rubbed through the sieve. This reduces the sugar somewhat, and the soluble salts. If children do not gain on protein milk, it is not because the salts are not administered.

DR. KOPLIK: There is a limit to the amount of sugar we can administer to these children. This is shown by the large amount that we can give in the form of malt sugar. The children gain for a while and then stand still, and finally lose, if we persist in administering this large amount of sugar and other carbohydrates. In other words, there is a natural limitation, and sugar can be given only within these limitations.

DR. GERSTENBERGER: I should like to know whether the amount of protein, in the cases in which large amounts of lactose were given, was high. I think a high protein content will allow of a much higher percentage of sugar than a low one, and that a low protein content most likely limits the amount of sugar.

I should like to ask Dr. Holt whether the buttermilk to which he has referred is real buttermilk or sour, skimmed milk. Most of the so-called buttermilk that we get in America is made in this manner.

DR. SHERMAN: While this paper may have no special reference to sugar tolerances, I should like to refer to some tests made in Buffalo regarding the reaction of sugar on gastric secretions. We took sixteen babies and fed them on 6 per cent. milk, 6 per cent. dextrimaltose and 6 per cent. cane sugar solution, dissolved in barley water, in order to give the mixtures enough bulk for our study. The babies took all the solutions very well. The average amount ingested was 130 c.c. We recovered, of the milk-sugar solution, withdrawing it in one hour, 23 c.c. Of the cane-sugar and malt-sugar solutions, we withdrew 34 c.c. Of these two solutions, we were able to withdraw almost 50 per cent. more than we were able to withdraw of the milk-sugar solution. This would look as if the milk sugar stimulated motor function more than either the cane sugar or the malt sugar. But that is probably not true, for the reason that the secretion following the ingestion of milk sugar was no greater than after the ingestion of the other two. The only conclusions that we reached from these few tests were that cane sugar or granulated sugar stimulates gastric secretion a little more than milk sugar, but that dextrimaltose stimulates the secretions twice as much as does milk sugar. This may be of some little importance; and it is wise to bear it in mind in treating some infants that have hypersensitive stomachs.

DR. GRIFFITH: Speaking from the clinical standpoint, I would say that I have been interested during this past winter in some investigations regarding high carbohydrate feeding which Dr. A. G. Mitchell has been carrying on under my direction at the Children's Hospital in Philadelphia. We have been using malt soups, which were made with different malt extracts, and in various ways; and have employed also buttermilk fortified with sugar and flour in the ordinary way. Our experience showed that from 10 to 13 per cent. of mixed carbohydrates was borne well, and that the children not only gained in weight on this, but maintained the weight they had gained. We had better results with high carbohydrate feeding than with any other in the average dyspeptic conditions; of course with numerous exceptions.

DR. DUNN: In reply to what Dr. Abt said, I would say that the problem that we are now studying is the possible damage that sugar produces.

In answer to Dr. Holt's question as to the permanence of the gain in our series, I would say that the gain in weight was maintained; but that simply means that these particularly selected babies were shown to have a high tolerance for sugar, which was cut down as soon as any symptoms of intolerance developed. Whether or not they go to pieces rapidly, however, after having been fed on this diet, depends on how long they have the symptoms of sugar indigestion and how much fat is fed. We have not obtained any figures yet; but my personal view is that one of the chief causes of these severe cases that cannot take fat is prolonged overfeeding with sugar, and its fermentation. Increasing the sugar until it causes fermentation, and continuing feeding with a high percentage of fat, will often cause a serious blow-up, such as occurred in a case seen by us since we wrote the paper; but these particular cases maintained their weight right along. When the sugar was cut down, however, the gain was not quite so rapid.

I want to agree strongly with what Dr. Gerstenberger said, that the amount of protein makes a great difference in the sugar tolerance. We gave, in the beginning, protein between 2 and 2½ per cent.; but later, it was kept at 1½ per cent.

In judging the possible effects of using sugar, it must be considered that it has been found that many specimens of lactose contain malt, gas-bacillus spores, and other things that cause trouble and make us draw wrong inferences. The lactose should be most carefully boiled.

Dr. Holt spoke of the percentage of sugar in albumin milk. Finkelstein now uses a higher percentage of sugar himself. We have used as high as 4½.

INDICATIONS FOR TREATMENT OF SEVERE DIARRHEA IN INFANCY

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No matter by what name we call it, there is a type of diarrhea which we all recognize as particularly serious in infants. It occurs chiefly in the summer and usually in children that have been the subject of previous attacks of diarrhea, and, as a result, are more or less malnourished. After perhaps a few days of mild diarrhea, the stools become large, watery and frequent. The infants are at first restless and sleepless; frequently stupor comes on, and oftentimes, coma. The urine is very scanty and extremely acid; it frequently contains albumin and casts and sometimes sugar, or at least some strong reducing body may be demonstrated. Respiratory symptoms are often present, especially toward the close of the disease; these may consist in a slightly increased ventilation of the lungs or the disturbance may be so great as to amount to very severe and very marked dysynea, inspiration following immediately on expiration without pause and with all the accessory muscles of respiration brought into play. There is, however, no evidence of obstruction.

Postmortem, the lesions are insignificant, even disappointing. The intestines and stomach are usually empty, the mucous membrane pale or slightly injected in certain areas, the lymph glands perhaps are somewhat swollen, and the liver, though oftentimes apparently normal, may be exceedingly fat.

This is the type of diarrhea which has been called "*Alimentäre Intoxikation*" by Finkelstein. It is quite markedly opposed in its symptomatology and in its clinical findings to ileocolitis or dysentery of infants.

When the chemical investigation of the diseases of the gastro-intestinal tract was first undertaken by Czerny and Keller and the men associated with them, it was found that the ammonia content of the urine of children with severe watery diarrhea was very much increased, so that the nitrogen in the form of ammonia, instead of forming less than 10 per cent. of the total nitrogen of the urine,

frequently was found to be 20, 30 perhaps even 40 per cent. of the total nitrogen. No abnormal acids could be found to account for this increase of ammonia and the reason for it was not understood until Steinitz showed that there was a very great loss of bases, chiefly sodium, by the bowel, and as a result of this, a relative acidosis occurred, and, there being less base to neutralize the ordinary acids in the urine, ammonia was either produced or deflected from the formation of urea in order to take the place of these bases. Numerous studies since then, especially the recent ones at the Babies Hospital, have confirmed these findings and have shown that the loss of alkali by the bowel may be very great.

So far as we know, no effort has been made to connect any of the other symptoms found in the picture of this disease with the relative acidosis. Czerny, years ago, in 1898, we believe, before any work had been done on the disease chemically, called attention to the fact that infants with severe diarrhea might show a dyspnea, and that this dyspnea simulated that which was found in rabbits when they were poisoned with mineral acids. Nothing further has been said in regard to the matter. Finkelstein has categorically stated and reiterated it over and over again that the symptoms in "*Alimentäre Intoxikation*" are due to products of intermediary metabolism imperfectly metabolized—indeed, the whole structure of his classification of diarrheal diseases of infancy rests on this statement. He regards this condition of "*Intoxikation*" as the last and most severe stage, the others differing from it only in degree and only as the result of the different intermediary products of the various foodstuffs.

It has seemed advantageous to investigate this form of disease further, and the most obvious indication for investigation has been given by the dyspnea which some of these children demonstrate. Dyspnea, when it is due to an acidosis, results in a diminution of the carbon dioxid tension of the alveolar air, or in the carbon dioxid percentage of the alveolar air. We have, therefore, during the last year (especially during the last summer) made determinations of the alveolar air. In order to do this it was necessary to obtain the air in such a manner that repeated observations on the same child would give approximately the same results. The methods of Haldane and Krogh and Lindhart, that utilize the air at the end of an expiration and which require intelligent cooperation on the part of the patient, obviously could not be used. The method of Plesch, which utilizes the

air from a rubber bag, which has been rebreathed for several seconds, was the only one that could be employed. We have been successful in obtaining the air so that with the same child on the same day and on different days, the results were uniform. When this alveolar air is examined in normal children, we find that the carbon dioxid tension differs among children slightly, but falls within the limits of the normal for adults, i. e., between 38 and 44 mm. pressure.

In children who have severe diarrhea, however, especially if dyspnea is present, we find that the carbon dioxid tension is very much lower than in health, and that the more severe the disease and the greater the dyspnea, the lower the carbon dioxid tension, and we have found also that when the children have recovered from the disease, as is sometimes the case, the tension rises. This low carbon dioxid tension is one of the evidences of an acidosis, and we have therefore sought for other evidences. We have examined the blood serum. Sellards showed that there was an alteration in the serum deprived of its protein, when acidosis was present, so that it no longer gave a marked color with phenolphthalein. The serum is shaken up with absolute alcohol, which precipitates the protein; the alcoholic filtrate is evaporated to dryness with a few drops of phenolphthalein. Almost as soon as the evaporation begins with normal serum, a reddish purple color develops and the dry residue is a deep purple. When acidosis is present in diabetes, uremia or cholera, evaporation may take place and no trace of color be found. Children with severe diarrhea show all grades, from a slight diminution in the color to complete absence of color.

We have also investigated the hydrogen ion concentration of the serum, using the dialysis indicator method devised by Marriott and Rowntree. The dialysate is compared with a solution of known hydrogen ion concentration, using phenolsulphonephthalein as an indicator. Under normal circumstances, the serum shows a hydrogen ion concentration of $10^{-7.6}$ to $10^{-7.8}$, while the serum of these patients showed, in severe forms of the disease, a marked reduction in the alkalinity and a hydrogen ion concentration perhaps as low as $10^{-7.2}$.

The urine of these children is very scanty and strongly alkaline. Sellards first and, later, Henderson and Palmer showed that the tolerance for alkalies could be used as an evidence of acidosis. In health, a certain amount of sodium bicarbonate brings about the production of an alkaline urine: in acidosis, a very much larger quantity is necessary

to do this. We have found that children with a severe diarrhea have a marked tolerance for alkali, whether given by mouth, subcutaneously or intravenously and that three or four, even five times, as much alkali is required to cause an alkaline urine as in health. We have also the evidence afforded by the giving of alkali in one of these ways which, when it has been taken in sufficient amount, brings about a normal hydrogen ion concentration of the blood, causes the Sellards test to give a deep purple color with phenolphthalein, stops the dyspnea and causes a return of the carbon dioxid tension of the alveolar air to normal or even abnormally high limits.

An examination of the urine for acetone bodies has usually been without result. In view of these findings, it seems perfectly fair to say that these patients are suffering from an acidosis and frequently from a very severe acidosis; that the acidosis is probably not due to abnormal acids—although it is conceivable that it might be due to some acids which we have failed to demonstrate—but that it is in all probability a relative acidosis brought about by a marked loss of alkali through the intestinal tract.

It is unnecessary to state that the acidosis is a dangerous condition and that it should be antagonized as rapidly and as completely as possible. It is of the therapeutic methods of attacking this that we wish particularly to speak. We do not intend to discuss the dietetic treatment of the condition. We have to combat an acidosis brought about by loss of material through the intestinal tract. It is, therefore, logical to give cathartics when we recognize the disease, when, let us say, a child with severe diarrhea is brought into the hospital? It is the usual practice, we believe, to give to such patients a preliminary cathartic in the form of calomel, castor oil or salts. As a routine, it is, we are sure, a bad practice. If the infant were distended, his intestines full of fermenting and putrefying material, if he had fever as the result of this, the condition would be different. The majority of these infants are not distended; their abdomens are greatly retracted and their intestinal tracts are almost entirely empty; if they are not empty, they will become so very rapidly by the increased peristalsis and the pouring out of increased intestinal secretions. What we accomplish by giving cathartics is to irritate still further an intestine already too greatly irritated.

Dr. Abt read a paper before this society some years ago and showed that all cathartics are irritants and cause an increased produc-

tion of mucus and frequently blood in the stools. What is accomplished by the giving of cathartics is not only to still further irritate the intestine, but to cause a still greater loss of the very substances which it is vitally necessary for the infant to retain in his body. What must be done is to cause a cessation of these stools and the drug which is most satisfactory for this is opium; and so we believe that it is the best practice to give opium in sufficient quantity to prevent more than four or five stools a day. That might be termed a prophylactic treatment.

The body is already so depleted that alkalies must be given, and sodium is the one that has been chiefly lost. It is, therefore, rational to give soda by mouth, and if it cannot be retained by mouth or by rectum in sufficient amount (and it is frequently rejected), it must be given either subcutaneously or intravenously. Intravenously is the method of choice, provided a vein is accessible. If this cannot be found (and the repetition of the injection makes frequent cutting operations inadvisable) the solution may be given subcutaneously, according to the method devised by Magnus-Levy and his pupils. The carbonate is very irritating and causes large areas of necrosis and the bicarbonate cannot be sterilized by heat without being largely transformed into the carbonate. This can be obviated by sterilizing a carbonate or bicarbonate solution and then transforming the carbonate back again into the bicarbonate, by passing under aseptic precautions carbon dioxid through the solution until the solution to which a drop or two of phenolphthalein has been added is entirely colorless. We have used this method without producing necrosis, but even under the greatest precautions there is always the danger of it. So if the bicarbonate solution can be given by mouth or intravenously, it is preferable. But however it is given, by mouth, subcutaneously or intravenously, a considerable quantity of water should be given with it, because these infants suffer not only from the lack of alkali, but from the continual drain of water from their tissues.

The sodium should be given in large enough amounts or sufficiently repeated to cause a cessation of the dyspnea and to cause a markedly alkaline urine. This does not, of course, mean that recovery will inevitably ensue. Even though all the acidosis has been overcome, there is still the severe diarrhea to be combated. The acidosis may

be entirely overcome, and yet death ensue as a result of it; it probably initiates many abnormal processes that we do not understand and that we have no way of overcoming.

We know that severe acidosis may be combated in adults, the acidosis entirely overcome and yet death ensue. For instance, with diabetes, the patient may go into coma, the urine be loaded with sugar and with abnormal acids, and yet life may be prolonged sufficiently so that all of the sugar may disappear from the urine and all of the abnormal acids; it would then be impossible to say from an examination of the patient that he was in the last stages of diabetic coma, and yet death ensues as a result of the diabetic coma. And so it is with these patients. The great majority of them die.

Finkelstein gives an unfair statement of what may be expected in this condition. He described first the nine cardinal symptoms that must be present in order that the diagnosis can be made, and he acknowledged that the condition is a very severe and fatal one, and yet, three years later, when discussing the value of *"Eiweissmilch,"* he says that he treated 18 patients with *"Intoxikation"* with but a single death, but instead of insisting on nine symptoms, he says that the diagnosis was made on the basis of stupor, fever and loss of weight. It is the other symptoms which are the danger signs, especially the dyspnea, but if we wait until the dyspnea is present for the diagnosis of acidosis, we are frequently too late. The increased ventilation of the lungs, which is one of the first signs, escapes observation. It can only clearly be made out by the examination of the alveolar air, which, in our experience, is altogether the sharpest of the symptoms; it shows the beginning of the process. Sellards' test, and especially the changes in the hydrogen ion concentration of the blood, are late changes and are only to be found when the protection of the organism has been overcome; when the last trenches have been carried.

It is not possible, of course, for these various tests which show an acidosis, to be made on patients in their homes or generally in hospitals. The apparatus is too cumbersome and the process too time consuming. It seems to us, therefore, that the only safe way to do is to cause a cessation of the diarrhea, when it is excessive and watery, as rapidly as possible and to give sufficient alkali with large quantities of water so that the urine will react alkaline.

And just a word in regard to the classification proposed by Finkelstein. This is based largely on the last stage which he believes he has

shown theoretically to be due to the intermediary products of the metabolism, as has been said, imperfectly elaborated, and, as he believes that he has shown that the other stages gradually merge into this, that they are all the same process, differing only quantitatively. It is much more probable from these studies that it is not the intermediary products of metabolism; indeed all proof of their presence is lacking. The condition depends on acidosis such as is found in cholera and a variety of other different diseases. The condition should not be, therefore, termed a food intoxication—it is not the presence of abnormal substances—it is the absence of substances that are very normal and very necessary to life.

DISCUSSION

DR. KOPLIK: I have been accustomed to teach that opium is a dangerous drug in these cases. It seems to send the children into a deeper stage of intoxication. It is difficult to gauge its dose in these severe cases of diarrhea in children. Why attempt to stop the so-called peristalsis of the gut, or diarrhea? Diarrhea is a means by which nature wishes to eliminate a certain amount of poisonous substance. If you reduce it in the gut by the use of opium, you have an absorption of all those noxious substances into the circulation, and increase the intoxication. Aside from this, I have found from clinical work that babies are best treated without any, even the mildest preparations of this drug.

DR. SCHLOSS: Dr. Howland's results seem to me absolutely conclusive, and show the point he wishes to make. During the last year I had an opportunity to make a few tests of a similar nature, determining the carbon dioxid in the blood, instead of in the alveolar air, which Dr. Howland has used. My results were absolutely comparable to his. In only a few cases did I have a chance to do the work on patients with severe intoxication and dyspnea; but in these I found that there was a marked lowering of the carbon dioxid in the blood—as low as 18 to 20, from a normal of 38 to 40 per cent. The ammonia quotient of the urine was also increased in a number of cases and occasionally there were acetone and diacetic acid in the urine; but this was inconstant.

DR. GERSTENBERGER: I should like to ask the dose that Dr. Howland used, by mouth and intravenously.

DR. KERLEY: We have intestinal intoxication cases that are identical with those Dr. Howland describes except in the matter of dyspnea. Does the presence of dyspnea constitute a class by itself, even though the cases may be alike in all other respects?

With regard to the use of opium, I believe that it is one of the best drugs for use in intestinal disease, but it must be employed in the right way. Drainage must be maintained through bowel evacuation, but it may be so excessive as to exhaust the patient. When such is the case opium should be employed with discrimination and moderation, watching the case carefully. One can thus prevent unnecessary loss of body fluids with their salt content.

DR. ABT: There is one thing that Dr. Howland did not speak of, probably for want of time, and that is the feeding of these babies. I should like to hear his opinion concerning this matter. This should not be disregarded, for it

seems even more important than the use of alkalies to give something that will prevent the patients from burning their own tissues—some food, whether carbohydrate, alcohol, sugar, or whatever is necessary in order to prevent acidosis.

DR. BLACKADER: May I just say one word about opium? The action of opium varies with the dose. It is rarely necessary to give a large dose of an opiate. Small doses relieve pain, secure sleep and rest, and by lessening the activity of the peristaltic movements permit the digestive fluids time to act on the weakened food which may be taken into the stomach. Very rapid peristaltic action even in health interferes with normal digestion, as any one may notice if he examines the stools after an active purge. Opium should never be given to children in doses sufficient to induce narcosis, but small doses, m iii - v of the camphorated tincture, in my experience do much good, and under the watchful care of an intelligent physician give rise to no dangerous symptoms.

DR. SEDGWICK: I think Dr. Howland has well said that this acidosis is a condition that may occur; and also that the treatment, in spite of its overcoming some of the symptoms, is not specific. Several years ago I became acquainted with the fact that in some of these cases of marked acidosis we have a creatinin excretion, which is known to be influenced in a similar way by acidosis to that in which carbohydrates and fats are influenced; and I believe that study along these lines would also be an aid in clearing this matter up. The two lines of study together might give an indication for the foods to be used, as Dr. Abt suggests.

DR. MORSE: It seems to me that this talk concerning the use or nonuse of opium in diarrhea is a question a good deal like that of the two men who were looking at different sides of the shield. Whether opium is indicated or not, depends, I think, on the circumstances in the individual case. If there is something in the bowel that ought to come out, then we should give a cathartic, and do not need opium. If, on the contrary, everything that has been doing harm is out, and the diarrhea is merely draining the tissues of water and salts, then we do harm with a cathartic and should give opium. It seems to me that the type of case that Dr. Howland speaks of belongs in the second class; that in which everything doing harm is out, and the diarrhea is merely draining the tissues of water and salts. In that case opium should be given.

Another point that occurred to me is whether, if there is such a free discharge of liquid and salts from the bowel, there is any absorption from the bowel, i. e., whether toxic substances could be absorbed from it. Is this condition not analogous to the old-fashioned cholera infantum, with everything coming out, and nothing going in? It seems to me that something else could be drawn as a conclusion from the paper; and that is the advisability, in many cases of diarrhea, of giving alkalies before the appearance of these severe symptoms.

DR. TALBOT: It is important in studying disease conditions to know the normal; and recently there has been more or less work with children and infants done in connection with physiologic acidosis, a condition in which they show the acidosis from fasting, and other work of that type. It is interesting that in studying a large number of new-born infants, we found that the respiratory quotient was very low on the second or third day of life. We have now one hundred and five new-born infants that we are about to report on. They showed the same low respiratory quotient found in the acidosis of diabetes. Curiously enough, however, we have found acetone bodies in the urine.

DR. HOWLAND: I dislike to use the term acidosis, because it has been so loosely applied to a number of different diseases in which a slight excess of the acetone bodies has been demonstrated. Normally, the acids of the acetone series are present in slight amount in the blood and urine. The fact that they can be demonstrated in small quantity in the urine does not mean that acidosis is present. It is only when the protective mechanism of the body is called into play that we can speak of acidosis. The infants on whom these observations were made showed practically no acetone bodies in the blood or urine.

I thought I had protected myself against Dr. Koplik's criticism. I said, "If the infants are distended, with high fever, with the intestines full of fermenting and putrefying substances, opium should not be employed"; but these infants do not usually come to the hospitals in that condition, but with retracted abdomens and intestines entirely empty, as they are found postmortem. Of course the diarrhea is, to a certain extent, a conservative process; but it is carried to an extreme in these cases, as many other processes of nature are. It is dangerous for an infant to have eight or ten large stools each day, containing a large quantity of alkali, the absence of which causes these symptoms. I would not advise giving a sufficient amount of opium to cause the patients to go into coma; but I think that opium is the most satisfactory drug with which to check abnormal peristalsis and abnormal loss of fluid. I give it in small quantities, a few drops after each loose stool; and if there are no more loose stools, no more opium is given. It is surprising how much these children can take without its influencing their stupor in the slightest degree.

Opium is a two-edged sword, and must be used very carefully; but all drugs that are efficacious are to a certain extent dangerous. If any effect is to be obtained, the drug must be given to its physiologic limit. There is no use in giving one drop of paregoric, any more than in giving one drop of the infusion of digitalis. When used for dangerous conditions, drugs must be given in sufficient amount to produce an effect.

So far as the dose of alkali is concerned, some children take more, and some less. We usually give 4 grams of alkali at a time, subcutaneously; and 5 or 6 grams intravenously. When given by mouth, we give 3 or 4 grams at a time. Even with excessive diarrhea, a number of these children, provided that they do not vomit, will absorb a sufficient amount to cause an alkaline reaction of the urine.

The dietetic treatment is very difficult. The children cannot be starved indefinitely. The appetite is almost always lost; and many vomit any form of food, or even the water, that is ingested. I believe that protein milk is the most advantageous thing to give, rather concentrated, and in small amount. The condition is a very serious one. The great majority of children die.

THE ETIOLOGICAL RELATIONSHIP OF SYPHILIS TO CHOREA OF SYDENHAM *

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The etiology of chorea is still a subject of speculation and investigation. It is true that in some cases microorganisms have been found in the blood. I need not mention that Sachs found a streptococcus in one case which he has called infectious chorea. Poynton also has found a diplococcus, but with the exception of these, the investigations into the etiology of Sydenham's chorea have been devoid of any definite results.

There is clinically an undoubted connection between chorea and endocarditis, between chorea and rheumatic joint manifestations, because in an overwhelming number of cases of chorea, there is not only a history of joint pains, but in cases of recurrent attacks there is a gradual but certain involvement of the endocardium. In many cases of purely rheumatic endocarditis there are periods in which, during the recrudescence of endocarditis, choreic manifestations make their appearance for a variable period of time. Moreover, in some cases of chorea, as the disease, even in the first attack, increase in severity, the endocardium becomes more and more seriously involved, with the appearance of murmurs, and even pericardial involvement, absolutely the counterpart of what is observed in purely rheumatic cases. Such a case is the following, of a child who, in her first attack of chorea, was carefully observed, and from mild symptoms, the chorea became more and more severe, to such an extent as finally to cause complete paralysis, loss of speech, and constant restlessness:—

Female, 8 years of age, admitted, March 17, 1915. Diagnosis, chorea minor paralytica, periendocarditis.

Family History.—Parents and four other children well.

Past History.—Measles. Attacks of tonsillitis since age of 2 years. No previous similar attack.

Present Condition.—Had attack of tonsillitis two weeks ago; two weeks later became fidgety, and five weeks ago exhibited choreiform movements of all limbs

* From the Children's Service of the Mt. Sinai Hospital.

and body, child being unable to stand or walk. Speech has become indistinct. Has been in bed five weeks. One week ago began to have attacks of sticking pain in left chest from shoulder to abdomen. Moderate degree of continuous fever. Four days ago began to have slight cough and small sores appeared on lips. History of recurrent attacks of tonsillitis.

Synopsis: Tonsillitis, choreiform movements, five weeks; pain in left chest, fever and herpes, one week.

Physical Examination.—General condition: acutely ill. Absolutely paralytic, and in constant choreiform motion. Speech impossible. Mind very much disturbed; irritable.

Head: Eyes negative; ears negative.

Mouth: Lips, ulceration at right angle; sordes. Teeth, sordes; tongue, strawberry type, sordes; pharynx, congested; tonsils slightly enlarged.

Neck: Negative.

Chest: Respiration rapid. Lungs, right: Anteriorly negative, and posteriorly negative. Left: Anteriorly dull in lower axilla; c absent breath sounds. Posteriorly dull to flat from spine of scapula to base. Bronchial respiration, and voice c; increased fremitus over this area, except at base, where breath sounds are absent.

Heart: Upper border, second rib; right border, sternum; left border, 4 inches to left of midline in third space; apex felt in fifth space, 3 inches to left of midline. Continuous thrill felt over base of heart. At apex is heard a to and fro friction. Also systolic blow. At base is heard a pericardial friction with greatest intensity at pulmonic area. Pulmonic second sound accentuated. Left border of heart merges with dulness in lower left axilla. Action is rapid, regular and of fair quality. Pulse likewise.

Abdomen: Retracted, soft, tympanitic. Liver indistinctly palpable ½ inch below free costal margin border, tender; spleen not felt; kidneys not felt; extremities negative; genitalia negative; spine negative; skin negative; glands. numerous small axillary nodes.

Synopsis: Generalized chorea, herpes, lung signs, cardiac signs, enlarged liver, glands palpable.

March 18: White blood corpuscles, 21,000; polymorphonuclears, 78 per cent.; lymphocytes, 22 per cent.; blood pressure, 120-70.

March 19: Much improved. Pericardial friction not as marked as yesterday.

March 22: Dull at left base with absent fremitus. Distant breath sounds, egophony — fluid in chest increasing. Temperature, normal.

March 31: Patient's general condition has rapidly improved. Lung signs have cleared, chorea likewise. Cardiac signs as to endocardial murmur unchanged.

Temperature 102 F. on admission. In twenty-four hours was about 100 F., and fluctuated between 100 F. and normal thereafter.

Pulse: 120 to 140 on admission; later 90 to 100.

In this case as the chorea increased in severity the heart became more and more involved, until a permanent lesion of the valves resulted. This child made a complete recovery from her paralytic chorea, but with a heart badly damaged as to its endocardium. Such a case, no doubt, is a convincing proof to one set of clinical observers that chorea is an acute or subacute infectious disease. The nature of

this infection and its mode of entry into the body is, as I have pointed out, still a matter of speculation. The term "rheumatic" is an unfortunate one, in that there has recently been a tendency to separate forms of endocarditis into those which are purely rheumatic and those which are infective, as if rheumatism was an entity which might exist without infectious organisms playing an etiological rôle in its occurrence, and also that endocarditis, complicating acute inflammatory rheumatism, might also be a disease in which infectious microorganisms might not play any rôle. This is, I think, wrong teaching, inasmuch as it is unfortunate to speak of chorea as rheumatic or not rheumatic.

The minute subdivision of disease etiologically is not a mark of clear clinical grasp of a subject. And so it may eventually be proven, not only that all endocarditis is infectious, whether or not accompanied by inflammatory manifestations in the joints, or mere joint pains, or in the absence of either. The same may be true of chorea. All chorea of the Sydenham type seems to me to be of an infectious nature. What it is we do not definitely know, but the whole clinical course of the disease speaks for this. The gradual or sudden onset, the advance toward severe manifestations, the gradual involvement of the heart, even in the absence of any temperature, and its final subsidence, speak in favor of the infectious theory. Finally, the recrudescence of symptoms after a lapse of months, and their subsidence with eventual involvement of an endocardium which at first was free from involvement, all speak for rather than against, the presence in the circulating blood of some infecting agent, whether it be so minute as to be not possible of cultivation, or whether our present culture methods do not reach it. Among others I have diligently had the blood cultured in many cases of chorea, but have failed to isolate any microorganisms.

Of late there has been an effort to connect chorea in an etiologic way with syphilis. This can be explained by the great impetus given to the study of the treatment of syphilis by the investigations which have revealed its etiology, but more especially by the attempt to cure syphilis in one stroke by means of a sovereign remedy. I refer to salvarsan. On the appearance of salvarsan, this remedy naturally was tried in a great variety of diseases whose etiology was obscure, and among them chorea. With the use of salvarsan in chorea, many saw a rapid advance in its therapy. The reason for the use of salvarsan in chorea is easy to find. Arsenic has for decades been a favorite remedy in chorea. In the form of Fowler's solution its use has been wide-

spread, with varying results. What with pushing the drug to the point of toleration by the mouth could be more natural than to apply the same drug in another form by injection into the circulation. Among the first to apply salvarsan, in the treatment of chorea, was Bokai, who thought it of great benefit in the treatment of the disease, especially in cutting short the duration of the affection. From this to a surmise by others that there might be a connection between chorea and syphilis, was but a step easily taken.

One of the first communications on this subject is that of Flatau, Germanns (*Ueber chorea luetica*) on so-called syphilitic chorea. In this case the chorea, as chorea, clinically does not appear one of pure Sydenham chorea. There were convulsions, meningeal symptoms, and the chorea was of five years' standing; Wassermann positive, ordinary chorea treatment ineffective, but a success on the injection of salvarsan with subsequent application of mercurial inunctions. There was in this case a history of hereditary syphilis. Salinger records a case of chorea minor in a girl hereditarily luetic, 10 years of age, given salvarsan with recovery in three weeks. More pretentious are the French communications on this subject. Especially notable are those of Milian on the syphilitic nature of Sydenham's chorea. He reports 15 cases of chorea with positive syphilis in 11 (73 per cent.). These cases had marked stigmata such as cranial anomalies or retarded development. Only 1, however, had a positive Wassermann reaction; 7 had cardiopathies, and 4 hereditary syphilis. Other cases by Apert and Rizard are mentioned. He concludes that syphilis is an important etiologic factor in chorea, as suggested by its symptoms (?) which at least do not exclude the possibility of its syphilitic origin. In another communication Milian reports 2 cases of chorea with a positive Wassermann reaction, which made a rapid recovery under mixed mercurial treatment. He further emphasizes the conclusion that chorea of Sydenham may have an acquired or hereditary etiology. Babonneix, in an appreciation of the work of Milian, contends that chorea is frequently luetic in origin, and gives a résumé of cases reported by Ingelrans in 1904, but rather leans to the presumption that chorea is rheumatic, and that the favorable action of arsenic in chorea is no proof of its luetic nature. Of 145 cases of chorea only 36 suggested hereditary syphilis.

Weill, Mouriquand and Goyet comment on the improvement of grave chorea by the injection of salvarsan in the rectum. In another note Weill, Morel and Mouriquand report cases of chorea treated

by rectal injection of salvarsan. Tribaulet finds that of 350 cases of chorea only 3 were suspected to have had hereditary syphilis. Szametz simply records a case of chorea treated by salvarsan, a rheumatic boy whose rheumatism was followed by chorea. Pawlow reports a similar case. In the bibliography attached to this paper will be found further references to the literature on the connection of syphilis to chorea, which are enough to show the widespread interest awakened by this subject within recent years.

In order to enlighten myself as to the relationship of syphilis to chorea, and for the benefit of the children, I took ten successive cases of chorea in my hospital service, of ages ranging from 6 to 13 years. In 5 of these cases there was an endocarditis on admission to the hospital, with an evident lesion of the valves; in 3 cases a distinct history of rheumatism or rheumatic pains; in 10 cases a Wassermann reaction was made, and in 8 the result was satisfactorily negative. In 2, the reaction, for one reason or another, failed, but was not positive. In all the cases there were absolutely no stigmata of syphilis, hereditary or otherwise, nor could syphilis be traced in any way in the family history. There is no reason why, had I subjected a large number of cases to the Wassermann test, I should not eventually meet cases in which it might be established that syphilis was present, either in the form of some lesion, or with the Wassermann reaction. For a child affected with syphilis might contract chorea just as readily as another, yet that would hardly prove the rule, to my mind. The presence of syphilis might be an accidental find, and not a causal element in the case. Nor are children affected with hereditary syphilis more prone than others to contract chorea; at least this is the impression one obtains from a study of the question. The attempt of some French writers to accept a luetic basis for chorea, on the ground that the salvarsan treatment is of especial effect in chorea, is, also, to my mind, not convincing. I desired for the benefit of the service, and also for these unhappy children, to test, not only this question in all its bearings, but also the very important question of the therapeutic action of salvarsan in chorea minor.

For this part of the work I enlisted the services of an expert in intravenous injections of neosalvarsan. Nine cases were thus injected with doses ranging from 0.15 to 0.4 gram of the drug. Of 7 cases thus injected, once or repeatedly, the effect, which in some quarters is described as striking, in that the symptoms immediately sub-

side, was not observed. Even after second and third injections the chorea continued to run its accustomed course. The average duration of the disease, after the last injection of the drug, was thirty-six days, in seven cases—certainly not encouraging. In another case a nephritis resulted and the patient was ill with chorea for some weeks though finally a recovery took place. Again, the administration of the salvarsan requires a certain amount of apparatus, and is not exactly applicable as a therapeutic measure in chorea. Nor can the drug be said to cause such striking improvement as to encourage a continuance of its use, nor does it prevent relapse. In fact, there is nothing in these results to warrant any assumption of a possible syphilitic or parasyphilitic influence, as a causative factor in chorea of Sydenham. I do not think we have in salvarsan an agent of any value above what has hitherto been in vogue in the treatment of chorea minor, nor do I feel that we are warranted in tracing any relationship between chorea of Sydenham and hereditary or acquired syphilis.

REPORT OF CASES

CASE 1.—Female, aged 12 years; occupation, schoolgirl; admitted Nov. 12, 1913; discharged Dec. 30, 1913; diagnosis, chorea minor.

Past History.—Measles, tonsillitis. Has had several attacks similar to present one for which she was in this hospital.

Present History.—For past seven months patient has had peculiar twitching movements of head, arms and legs. Speech has become affected, but can walk.

Examination.—Patient not acutely ill. Has choreiform movements of head, arms, legs and trunk. Speech indistinct. Heart: at apex is heard soft, blowing systolic murmur transmitted out to axilla; pulmonic second accentuated.

November 14: As patient walks she has a choreic strut, moves upper extremities, muscles of head and face. As she lies in bed she is in constant motion. Movements of tongue, face and extremities are evident. Neosalvarsan 0.3 gram given.

December 3: Neosalvarsan 0.3 gram given. Temperature ranged between 98 and 99.6 F., occasionally 97.8 or 100 and 100.2 F.

Urine: November 13, amber; clear; acid; 1.030; trace acetone and trace indican; occasional white blood cells. After November 13, urine amber; acid; 1.022-1.040; on December 24, calcium oxalate crystals present.

Laboratory Examination.—November 14, Wassermann: Serum too anticomplementary for testing. Dr. Kaliski.

CASE 2.—Female, aged 12 years; admitted Dec. 7, 1913; discharged December 22, 1913; diagnosis, chorea minor.

Past History.—Measles, whooping cough, scarlet fever, frequent attacks of tonsillitis for which tonsillectomy was done. Has had attacks of rheumatic pains.

Present Illness.—For the past few weeks child has been nervous, with twitching movements of hands and legs. Has had no fever. Also complains of rheumatic pains in all joints and occasionally in heart.

Examination.—Patient fairly well nourished; at times choreic movements of hands and legs. Examination otherwise negative.

December 8: Systolic murmur over the apex half way between sternum and apex, mild in character.

December 17: Neosalvarsan 0.15 gram given.

December 22: Neosalvarsan 0.3 gram given.

Temperature: Ranged between 99 and 100, occasionally 98 or 98.6, once 97.8.

Urine: Amber; acid; 1.024-1.044; on one occasion (Dec. 17) very faint trace albumin; many epithelial cells, calcium oxalate crystals.

Laboratory Examination.—December 8, Wassermann test negative. Dr. Kaliski.

CASE 3.—Relapsing chorea. Male, aged 12 years; occupation, schoolboy; admitted Feb. 17, 1914; discharged Feb. 17, 1914; diagnosis, chorea minor.

Past History.—Scarlet fever at 6 years of age, complicated by measles, pneumonia and chickenpox. Suffered with severe epistaxis at that time for which he was treated by a laryngologist who removed adenoids and tonsils. In general, patient bleeds much after injuries. After scarlet fever, patient had chorea for three weeks. Was treated in this hospital. On June 2 neosalvarsan 0.2 gram was given, with marked improvement of symptoms on June 10; discharged from hospital on June 12, 1913.

Present Illness.—Onset two weeks ago with twitchings involving arms, legs, face and tongue. Has difficulty with speech. Cannot play with other children. Complains of "tired feeling." Can control twitchings better in school than at home. Movements do not cease at night and sleep is consequently disturbed.

Examination.—General condition good. Choreiform movements moderate in severity, involving entire body including tongue and face.

Heart: Negative except for reduplicated first sound at apex.

Temperature ranged between 98.4 and 100 F.

Bedside Notes: Hot colon irrigations; warm packs.

CASE 4.—Female, aged 6 years; admitted Sept. 11, 1913; discharged Nov. 23, 1913; diagnosis, chorea minor.

Previous History.—Had measles and scarlet fever two years ago.

Present Illness.—For the past week mother has noticed that child moves its limbs and body involuntarily. No symptoms pointing to cardiac or renal disturbance.

Examination.—General condition fair; marked incoordinate twitching of muscles of entire body. Skin scaly, erythematous rash on face. Examination otherwise practically negative.

September 17: Patient received 0.15 gram neosalvarsan intravenously.

September 22: Patient received 0.3 gram neosalvarsan intravenously.

September 25: Patient received 0.3 gram neosalvarsan intravenously.

September 29: Vaginal smear negative for gonococci.

September 30: Choreic twitchings are still very marked. Urine shows evidence of slight nephritis.

October 2: On account of some red blood cells in the urine, injections of neosalvarsan are discontinued.

October 6: Rests at night; chorea less; appetite good; fingers more involved than rest of arm.

October 16: Though the patient has less choreic movements, she is unable to walk.

October 22: Improving daily; sitting up, walking; choreic movements scarcely noticeable.

Temperature: September 11, 98.4-101 F.; September 12-17, 98.4-100.2 F.; September 18-24, 98-100.2 F.; September 25-October 1, 98.6-99.8; October 2-3, 97.6-98 F.; October 4-8, 98-99.4 F.; October 9-22, 98.6-100 F.; October 23-29, 98.8-100.6; October 30-November 5, 98-100 F.; November 6-19, 98.4-99.6 F.; November 20-23, 98-100.2 F.

Urine: September 12-24: Clear; acid; white blood cells; hyaline and granular casts. October 1: Clear; acid; few red blood cells; white blood cells and epithelial cells.

CASE 5.—Male, aged 7 years; occupation, schoolboy; admitted Sept. 12, 1913; discharged Nov. 27, 1913; diagnosis, chorea paralytica Sydenham. Large necrosis of skin and furuncles.

Previous History.—Had measles three years ago. Similar attack to present one two years ago.

Present Illness.—For past two weeks patient has had involuntary twitching of muscles of limbs and trunk. No cardiac or urinary disturbances.

Examination.—General condition fair; marked incoordinate twitchings of muscles of face and extremities; skin, abrasions over right knee; lungs, negative; heart, slight impurity of first sound at apex; extremities, knee-jerks exaggerated.

September 30: Has developed two furuncles over right shoulder region. Lower and larger of two has necrotic center; dressed with wet dressing.

October 3: Acne and furunculosis; large area of necrosis size of quarter at angle of scapula; acne eruption all over; furuncle on calf of right leg, forearm of right extremity of angry, green color. He lies absolutely helpless in constant motion, hands sometimes clenched. No knee jerks obtainable. Is irritable and then laughs. Unable to lift the left hand to any extent; can lift both extremities upper and lower, very incoordinately; right upper stronger than left. Musculature of right upper extremity appears stronger than left. Patient is restless at night.

October 4: Abscess present on right forearm. Incision one-half inch long made over this and a good deal of pus expressed.

October 5: Incision insufficient for drainage of abscess of right forearm. Sinus about two inches in length present.

October 10.—Today there is a fair sized abscess in calf of right leg; this was incised and pus liberated. Abscess in arm shows slight discharge. Lesions on back are healing rapidly. Furuncles on tragus of right ear.

October 18: All wounds healed. Because of tendency toward drop foot, starch bandage was put on right foot.

November 26: Perfect physical condition; no sign of chorea.

Temperature: September 12, 97-99 F.; September 13-18, 98.2-99.8 F.; September 19-25, 98-99.2 F.; September 26-October 2, 98-101.2 F.; October 3-9, 98.8-102.6 F. October 9-November 27, temperature ran between 98 and 99.2 F., with occasional drops to 97 F.

Treatment: Warm packs. October 9, injection of staphylococcus vaccine, 20,000,000; October 12, injection of vaccine, 20,000,000; October 16, injection of vaccine, 20,000,000; October 20, injection of vaccine, 40,000,000.

Urine: Usually clear; amber; acid; microscopically negative.

Laboratory Examination.—October 2, Wassermann test, negative. Dr. Kaliski.

October 4: Pus from furuncle: *Staphylococcus pyogenes aureus* (vaccine in preparation). Dr. Celler.

CASE 6.—Female, aged 6 years; admitted Sept. 12, 1913; discharged, Nov. 28, 1913; diagnosis, chorea minor.

Past History.—Had measles at age of 2; no rheumatism or scarlet fever.

Present Illness.—For the past four months child has been exhibiting involuntary movements of muscles of face, trunk and extremities. No cardiac or urinary disturbances.

Examination.—Incoordinate twitchings of hands, arms, legs and mouth. Skin: Scattered patches of clotted blood over extremities. Furuncle on right thigh. Heart and lungs, negative.

September 30: Choreiform twitchings less marked than on admission. Child has a diffuse rash over whole body. Vaginal smear negative for gonococci.

October 3: Child has an eruption on surface of body which may be a bromid acne. The muscles of face, arms and lower extremities affected. Choreic movements, reflexes of knee present, but sluggish. Chorea of tongue and face. Holds head perfectly and when sitting up is in constant motion. Will not stand, or walk, and has outbursts of crying when attempting to walk.

October 6: Neosalvarsan 0.225 gm. intravenously.

October 7: Condition not improved.

October 11: Patient received 500 units of diphtheria antitoxin.

October 15: Neosalvarsan 0.2 gram given intravenously.

October 22: Markedly choreic, subject to fits of temper. Cannot walk or stand. Facial movements. Neosalvarsan 0.215 gram given intravenously.

November 26: Still habit movements; mental status not normal.

Temperature: September 12-October 6, 98-99.6 F.; October 7, 97.8-100 F.; October 8-15, 97.8-100 F.; October 16, 98.4-101.2; October 17-21, 98-100 F.; October 22, 99-102.4 F.; October 23-30, 98.6-99.8 F.; October 31-November 14, 97-99 F.; November 15-28, 98-99.2 F.

Treatment.—Warm packs. Ears irrigated. September 12, mixed bromids given; September 16, bromids stopped.

Urine.—Clear; acid; 1.022-1.034; occasionally calcium oxalate crystals present; on October 1 and 15 occasional white blood cells.

Laboratory Examination.—October 2, Wassermann test negative. Dr. Kaliski.

CASE 7.—Male, aged 8 years; admitted Sept. 25, 1913; discharged Nov. 23, 1913; diagnosis, chorea minor.

Previous History.—Had measles.

Present Illness.—Onset three weeks ago with fever and headache. Has vomited three or four times since onset, vomiting not projectile. Bowels normal; appetite poor.

Examination.—General condition good. Choreiform twitchings of hands and arms, feet and legs. Mouth: Teeth and gums poor; tongue coated. Examination otherwise negative.

October 10: Though patient lies in bed quietly and with mild chorea in bed, is unable to walk.

October 15: Received 0.2 gram neosalvarsan.

October 17: Choreic movements mild, but present especially of tongue and face.

October 18: Patient this morning is rather more disturbed and nervous than he has ever been, and it is barely possible that the treatment and excitement has been the direct cause. Salvarsan treatment stopped.

October 22: Upper and lower extremities and face and tongue in constant motion.

Temperature: Temperature ranged between 98 and 99.8 F., occasionally 97 or 97.6 F., and on three occasions reached 100 F.

Bedside Notes: Warm packs, cold rubs, aspirin and bromids given.

Urine: October 17, turbid; acid; calcium oxalate crystals; amorphous urates. October 22, calcium oxalate crystals.

Laboratory Examination.—October 9.—Wassermann test negative. Dr. Kaliski.

CASE 8.—Male; aged 8 years; admitted Oct. 12, 1913; discharged Oct. 25, 1913; diagnosis, chorea minor, scarlet fever.

Family History.—Mother and father well; two other children are well; history otherwise negative.

Past History.—Measles at 4 years. Whooping cough at 5 years.

Present Illness.—Onset began about three months ago when his violin teacher noticed that the boy could not use his bow properly in playing the instrument. Since then he has also had muscular twitchings at other parts, shoulders, trunk, head and lower extremities. The boy has improved somewhat under a physician's treatment.

General Condition: Boy well nourished; very slight choreic movements. Eyes: No palsies and no nystagmus. Mouth: Tongue moves irregularly on protrusion. Tonsils: Moderately enlarged. Lungs: Negative. Heart: Pulmonic second sound slightly accentuated, otherwise heart is negative. Liver: Negative. Spleen: Negative; extremities, knee-jerks obtainable.

October 15: Patient received 0.2 grams neosalvarsan intravenously.

October 17: Patient has not improved; can stand alone, but walks with an incoordinate gait. Slightly choreatic in all extremities and muscles of the face.

October 22: Patient received 0.215 grams neosalvarsan intravenously.

October 24: Patient today developed an indefinite punctate rash over body, which is very prominent posteriorly (rubeola).

October 25: Transferred to Willard Parker Hospital.

Temperature: October 12, 100.4 F.; October 13-21, 98-99.8 F.; October 22, 98.6-100 F.; October 23, 98.8-103.8 F.; October 24, 102.6-104 F.; October 25, 100.4-103.2

Urine: Negative.

CASE 9.—Female, aged 7 years; admitted Oct. 16, 1913; discharged Nov. 27, 1913; diagnosis, chorea minor.

Past History.—Measles, chickenpox. Following measles one and one-half years ago, child developed chorea. Was in this hospital five months ago for

this ailment. Since onset one and one-half years ago child has had several attacks of tonsillitis and one attack of rheumatism.

Present Illness.—Child has had a recurrence of choreiform movements. No sore throat, fever or rheumatic pains. Walks unsteadily and speaks indistinctly.

Examination.—Generalized choreic movements present. Heart: At apex soft blowing systolic murmur transmitted to left; pulmonic second sound accentuated. Extremities: Knee-jerks and Achilles present.

October 18: Stool; no ova present.

October 22: Child has mild choreic movements of face and extremities, somewhat incoordinate in walking. Case of mild severity. Systolic murmur at apex. Neosalvarsan 0.215 gram given.

October 24: Patient's movements just the same as before injection.

October 29: Neosalvarsan 0.215 gram given intravenously.

November 7 : Patient has not improved since last injection.

Temperature: Ranged between 98 and 99.8 F., with occasional rises to 100 F., once 100.6 F.

Treatment.—Cold packs. October 22, vomited.

Urine: October 22, clear; acid; 1.038; trace indican; calcium oxalates; October 29, clear; triple phosphates; November 19, acid; 1.030; ammonium urates.

Laboratory Examination.—October 19, Wassermann test negative. Dr. Kaliski.

CASE 10.—Female, aged 13 years; admitted Oct. 16, 1913; discharged Nov. 27, 1913; diagnosis, chorea minor.

Past History.—Measles, scarlet fever, tonsillitis four years ago after which her tonsils were removed. At same time child had attack similar to the present one. No history of rheumatism.

Present Illness.—Present attack began three months ago with violent movements of arms, legs, head and trunk. Child is unable to walk steadily and talks indistinctly. No fever, no rheumatic pains.

Examination.—Marked generalized choreic movement and speaks with difficulty. Heart: At apex soft blowing systolic murmur transmitted to base; pulmonic second accentuated. Extremities: Knee-jerks and Achilles present.

October 18: Polynuclears, 59 per cent.; small lymphocytes, 29.5; large lymphocytes, 5; eosinophils, 6; basophils, 0.5. Stool: Moderate number of ova of trichocephalus dispar present.

October 22: Patient is very incoordinate; muscles of face and extremities are in constant motion. Walks incoordinate and presents a picture of a case of moderate severity. Systolic murmur present at apex. Neosalvarsan 0.215 gram given.

October 29: Still very choreic as to tongue, face, extremities; cannot walk.

October 29: Neosalvarsan 0.4 gram given.

November 17: Slight improvement. Melancholic expression; incoordination of movements still present.

Temperature: Usually ranged between 97.8 and 99.8 F., with occasional rises to 100 or 100.2 F.

Urine: October 22, acid; indican present; 1.026; calcium oxalates; after October 22, urine negative.

Laboratory Examination.—October 19, Wassermann test negative. Dr. Kaliski.

CASE 11.—Female, aged 6 years; admitted Jan. 19, 1914; discharged March 12, 1914; diagnosis, chorea minor.

Past History.—Measles at second year. Rheumatism at third year, involved hands and feet, swollen, hot, much fever. Duration six weeks.

Present Illness.—For last eight days father has noticed twitching of mouth, hands and feet and difficulty with speech.

Examination.—General condition fair. General choreiform movements of face, arms, legs and trunk. Speech: Difficulty in starting. Nodes generally enlarged. Heart: Action somewhat irregular (nervous type). Soft systolic at apex. Pulmonic second much accentuated.

January 20: Von Pirquet negative.

January 22: Twitchings when at rest and in bed and face flushed.

January 26: Neosalvarsan 0.15 gram given.

January 27: Patient seems more nervous than usual.

January 30: Patient not improving under salvarsan. Treatment with aspirin and bromids ordered.

Temperature: Ranged between 98.4 and 100 F., once 101 F.

Treatment: Warm packs and cold packs. Mixed bromids and aspirin.

Urine: Amber; acid; occasional hyaline casts and calcium oxalate crystals.

Laboratory Examination.—January 27, Wassermann test negative. Dr. Kaliski.

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DISCUSSION

DR. LAFÉTRA: Dr. Koplik has stated that in blood cultures made in cases of chorea he had found no positive results; but there are recorded in medical literature cases in which the *Streptococcus viridans* has been isolated from the blood of patients suffering from chorea. Several such cases have been demonstrated in Bellevue Hospital, two in my own wards.

DR. SAUNDERS: I wish to thank Dr. Koplik for his demonstration, and for liberating our minds from the incubus under which they have been laboring. In this connection, I should like to mention a sign of chorea that I have found valuable for many years. It is this: You know that a child in the first septennium of life, and perhaps in the second, when asked to open its mouth widely, will separate its fingers. That is the normal association of opening the mouth for a young child. In chorea, the children lose that association movement; and this is the earliest sign of that disease that I can find. There may be a slight flexion of the fingers in chorea, but never the spreading movement. Of course we do not need many diagnostic signs of chorea; but I have seen one or two cases of tic in which it was valuable to have the diagnostic sign that I have mentioned. As a prognostic sign, also, it is very valuable. When I find a child's disposition changing, so that it is getting very nervous and fretful, and notice that its movements are somewhat ataxic, I ask it to open its mouth; and if it does not at the same time separate its fingers, I put it to bed. When the child is supposed to be cured of an attack of chorea, I wait until I see that vigorous association movement before considering it beyond the possibility of relapse. I hope that you will all watch for that sign, which I have found so useful.

DR. ABT: With reference to the arsenic therapy of chorea, I wish to say that for a long period I adhered exclusively to the arsenic treatment. In the course of my observations on this disease, however, I noticed that some children became ill with neuritis following the use of the arsenic; and I concluded that this drug must be employed cautiously and I personally abandoned its use. For many years, now, I have relied almost exclusively on the rest treatment, and in those cases which are associated with rheumatism, on the use of salicylates. I hesitate to make any dogmatic statement, but I believe arsenic to be of no value in the treatment of chorea during the active stage.

DR. KOPLIK: In the first part of this paper I mentioned the micro-organisms found in the blood in certain cases of chorea. I did not mention the cases referred to by Dr. LaFétra as having had the *Streptococcus viridans* isolated from the blood. We have cultured many cases of chorea within the last two or three years and have not been able to discover organisms. Possibly that may be explained on many grounds; but the fact remains that we have not found anything in the blood. One of my associates in the hospital has even cultured the lumbar-puncture fluid.

We have tried in various ways to find a filterable virus, but have been unsuccessful. We may be able to do so later, when the technic improves.

As to the use of arsenic, I merely mentioned that as one of the favorite remedies. Arsenic is very useful, I find, as a tonic in the after treatment of chorea; and there is no doubt that some cases which will not yield to salicylate, bromids or rest, will improve with the arsenic treatment. I feel rather uncertain, however, about its utility in the way in which it is employed today; and that is the principal reason why I brought forward the facts in this paper.

NATURE AND QUANTITATIVE DETERMINATION OF THE REDUCING SUBSTANCE IN NORMAL AND PATHOLOGIC CEREBROSPINAL FLUID*

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NEW YORK

I. INTRODUCTION

During the past year we have had opportunity to make a series of quantitative determinations of the reducing power of various specimens of normal and pathologic cerebrospinal fluid, and also to carry out certain observations concerning the nature of the reducing substance. The data thus derived serve as the basis of this communication.

II. THE NATURE OF THE REDUCING SUBSTANCE

It is generally assumed that the reducing agent in cerebrospinal fluid is dextrose — the sugar of blood and body fluids. A review of the literature, however, discloses that there has been considerable divergence of opinion. Halliburton,[1] whose views are quoted in several current textbooks, concluded that the reducing substance was pyrocatechin or a pyrocatechin derivative. Connall[2] states that it is galactose, although he gives no references or experimental data to uphold this view. The observations of Nawratski,[3] Zdarek,[4] Rossi[5] and others, however, indicate that the reducing agent is a fermentable, dextrorotatory sugar, presumably dextrose.

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* From the Children's Wards and the Pathological Laboratory, Bellevue Hospital, New York.

1. Halliburton: Text Book of Chemical Physiology and Pathology, London, 1891. Thompson, Hill and Halliburton: Observations on the Cerebrospinal Fluid in the Human Subject, Trans. Path. Soc., London, 1899, liv, 344.

2. Connall: A Study of the Cerebrospinal Fluid in the Infective Diseases of the Meninges with Special Reference to Cerebrospinal Fever, Quart. Jour. Med., 1909, iii, 152.

3. Nawratski: Zur Kenntniss der Cerebrospinalflüssigkeit, Ztschr. f. physiol. Chem., 1897, xxiii, 533.

4. Zdarek: Ein Beitrag zur Kenntniss der Cerebrospinalflüssigkeit, Ztschr. f. physiol. Chem., 1902, xxxv, 211.

5. Rossi: Sulla natura della sostanza reducente contenuta nel liquido cephalorachidea, Clin. med. ital., 1899, xxxviii, 422.

In order to obtain additional evidence on this subject we made the following experiments:

Mixed specimens of practically normal[6] cerebrospinal fluid, from 460 to 700 c.c. each, were precipitated with absolute alcohol, filtered and evaporated at a low temperature in slightly acid solution to a volume of 30 c.c. The resulting solution was filtered and subjected to tests, the results of which may be summarized as follows:[7]

1. Quantitative determination of the reducing substance as dextrose by Benedict's solution gave percentages of 0.86 to 1.3.
2. The solutions were dextrorotatory and the rotation corresponded to a percentage of dextrose nearly identical with that obtained by Benedict's reagent.[8]
3. The solutions were fermented by yeast with the production of alcohol and carbon dioxid. The mixture was acid in reaction (litmus).
4. A crystalin osazone was obtained which was insoluble in hot water, soluble in alcohol and pyridin and melted at 200 to 208 C.
5. A repetition of the procedure of Halliburton gave no precipitate of pyrocatechin.

It has been found by a number of observers that the reducing substance in cerebrospinal fluid is destroyed by bacterial growth in twenty-four to seventy-two hours. We were able to confirm this observation on a number of occasions. It therefore seemed only rational to assume that if the reducing action of cerebrospinal fluid were due to pyrocatechin, the reducing power of this substance should be destroyed by bacterial growth. With this idea in mind the following experiment was made:

Pyrocatechin was dissolved in nutrient broth in sufficient quantity to give a reducing action equal to normal cerebrospinal fluid. This reducing power was not appreciably decreased by bacterial growth.

The observations cited indicate that there is no basis for the belief that the reducing substance in normal cerebrospinal fluid is pyrocatechin. Moreover, our results indicate that this agent is a monosaccharid, probably dextrose.

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6. Part of the fluid in one specimen was from a patient affected with hydrocephalus, and from one with tuberculous meningitis, but both specimens of fluid contained a normal amount of the reducing substance.
7. These experiments were made on three separate collections of material.
8. The exact results were as follows:

Specimen	Dextrose P. C. Benedict's Solution	Dextrose P. C. Polarimeter
1	0.86	0.77
2	0.97	1.2
3	1.3	1.12

III. QUANTITATIVE DETERMINATIONS OF THE REDUCING AGENT IN CEREBROSPINAL FLUID

But few determinations of the reducing agent in cerebrospinal fluid have been made and these concerned normal or nearly normal material. Owing to the small amount of this substance usually present, a number of the estimations were made on mixed specimens of fluid obtained from several patients and therefore give no idea of the normal fluctuations. So far as we can ascertain, there have been no quantitative determinations of the reducing power of cerebrospinal fluid in meningeal diseases.

TECHNIC

By means of the method of Lewis and Benedict[9] for the quantitative determination of blood sugar we were able to make accurate determinations of the reducing power of cerebrospinal fluid by using quantities of 5 c.c. or even less.[10] During the course of the work qualitative tests for comparison were made with Benedict's and Fehling's solutions. We found the reagent of Benedict the more satisfactory, and after experiment adopted the following procedure. To exactly 5 c.c. of the reagent were added 12 drops of cerebrospinal fluid. The mixture was kept at boiling temperature for one to two minutes and allowed to cool spontaneously. The test was usually positive when the fluid contained 0.05 per cent. or more of dextrose.

The Sugar Content of Normal Cerebrospinal Fluid.—The results for normal fluids were obtained from a study of material from forty-five infants and children (Table 1) on whom lumbar puncture was done as a diagnostic procedure. There were a number of cases of meningism, but all fluids showed a normal cell count and no increase of globulin (Kaplan, Noguchi). The maximum amount of sugar found in normal cerebrospinal fluid was 0.139 per cent., the minimum 0.054 per cent. As shown in the table, the amount of sugar contained in the different fluids varied greatly. The cause of this variation is not apparent, but it seems probable that the amount of sugar in each individual may vary from time to time, as is true of blood sugar. Owing to the method of obtaining cerebrospinal fluid, it is

9. Lewis and Benedict: A Method for the Estimation of Sugar in Small Quantities of Blood, Jour. Biol. Chem., 1915, xx, 61.

10. Five cubic centimeters of cerebrospinal fluid was delivered into a 25 c.c. volumetric flask from an Ostwald-Folin pipet; 10 c.c. of a saturated aqueous solution of picric acid were added; the mixture made up to 25 c.c. with water and filtered. Aliquots of 8 c.c. were used and to each was added 2 c.c. of the aqueous picric solution. Otherwise the method corresponds to the description of Lewis and Benedict.

TABLE 1.—The Percentage of Dextrose in Normal Cerebrospinal Fluid

No.	Diagnosis	General Characteristics	Per Cent. Dextrose
1	Lobar pneumonia, otitis media	Clear; no increase of pressure; no globulin; no cells	0.0756
2	Acute tonsillitis, meningism	Clear; no cells; no globulin; pressure moderately increased	0.09
3	Congenital deformity, lobar pneumonia	Normal	0.1390
4	Tuberculosis of spinal column	Normal	0.08
5	.....	Normal	0.065
6	Convulsions	Normal	0.08
7	.....	Normal	0.0992
8	Tuberculous bronchopneumonia, otitis media, rickets	Normal	0.0692
9	.....	Normal	0.0674
10	Bronchopneumonia	Normal	0.0348 *
11	Septicemia	Normal	0.094
12	Malnutrition, meningism	Normal	0.056
13	Lobar pneumonia	Normal	0.075
14	Gastroenteritis, bronchopneumonia; meningism	Normal	0.059
15	Myelogenous leukemia	Normal	0.118
16	Toxic psychosis	Normal	0.062
17	.....	Normal	0.0692
18	Malnutrition	Normal	0.0692
19	Tuberculous bronchopneupneumonia	Normal	0.08
20	Rickets	Normal	0.071
21	Gastro-enteritis, meningism	Normal	0.0134 *
22	Pneumonia, meningism	Pressure increased; otherwise normal	0.0674
23	Lobar pneumonia	Normal	0.088
24	Acute otitis media, pneumonia	Normal	0.0692
25	Empyemia	Normal	0.134
26	Malnutrition	Normal	0.065
27	Malnutrition	Normal	0.0786
28	Otitis media, meningism	Normal; 18 cells	0.064
29	Otitis media, meningism, pneumonia	No globulin; 11 cells; pressure much increased	0.0818
30	Pneumonia, acute parenchymatous, nephritis	Normal pressure +	0.0196 *
31	Acute gastro-enteritis, meningism	Normal pressure +	0.0592
32	Rickets, internal hydrocephalus	Normal	0.0588
33	Acute otitis media, meningism	Normal	0.075
34	Convulsions	Normal	0.066
35	Gastro-enteric intoxication, meningism	Pressure +; otherwise normal	0.1390 *
36	Cretinism, lobar pneumonia	Normal	0.0786
37	.....	Normal	0.063
38	.....		0.057
39	Malnutrition	Normal	0.1042

TABLE 1.—(*Continued*)

No.	Diagnosis	General Characteristics	Per Cent. Dextrose
40	Gonococcus, vaginitis	Pressure +; otherwise normal	0.066
41	Pertussis, meningism	Pressure +; otherwise normal	0.064
42	Septicaemia	Normal	0.091
43	Tetany	Normal	0.066
44	Pneumonia, meningism	Normal	0.085
45	Convulsions	Pressure +; otherwise normal	0.0486
46	Epilepsy	Normal	0.065
47	Rheumatic fever	Normal	0.094
48	.....	Normal	0.0836
49	Bronchopneumonia	Normal	0.1042

* Moribund.

TABLE 2.—Sugar Content of Cerebrospinal Fluid in Epidemic Cerebrospinal Meningitis

No.	Age Years	Dextrose Per Cent.	Remarks
1	11	*	Ill two days. Delirious.
		0.09	Second specimen. Following day intraspinal injections of antimeningococcic serum.
		0.08	Following day improvement.
		0.0868	
		0.0818	Great improvement.
2	⅓	0.0134	
		0.0134	Following day worse.
		0.0134	Death.
3	⅓	*	Condition poor.
		*	Seven hours later treated with serum. Recovery. Other specimens not obtained.
4	5½	*	Very ill. Treated with serum.
		0.036	Following day.
		0.0459	Following day.
		0.051	Fourth day. Great improvement. Recovery.
5	3½	*	Moderately ill. Serum treatment.
		0.0459	Improvement.
		0.059	Very much better. Recovery.
6	.....	0.075	Very ill. Serum treatment.
		0.058	Following day improved.
		0.062	Much better. Ultimate recovery.
7	.....	0.027	Very ill. Serum.
		0.065	Condition worse. Following day.
		0.04	Much worse. Death.
8	.....	*	Very ill.
		0.0362	No apparent improvement. Following day.
		0.05	Two days later. Much improved.
		0.057	Two days later. Much better. Recovery.

* Too small to determine.

TABLE 3.—Sugar Content of Cerebrospinal Fluid in Tuberculous Meningitis

No.	Age Years	Dextrose Per Cent.	Remarks
1	7	0.035	
		0.0324	Two days later.
		0.0674	Three days later. Tubercle bacilli in spinal fluid.
2	2½	0.0674	Autopsy. General miliary tuberculosis.
		0.0318	Tubercle bacilli in cerebrospinal fluid.
3	9		Autopsy. General miliary tuberculosis.
4	4	0.0454	X-Ray. General miliary tuberculosis.
5	4	0.0314	
		0.0338	Two days later.
		0.0334	Four days later. Tubercle bacilli in cerebrospinal fluid.
6	11	0.0294	Tubercle bacilli in cerebrospinal fluid. Autopsy. General miliary tuberculosis.
7	1 1/12	0.0330	First specimen.
		0.0380	Second specimen. Tubercle bacilli in cerebrospinal fluid.
8	2½	0.056	First specimen.
		0.0464	Second specimen. Tubercle bacilli in cerebrospinal fluid.
9	5½	*	First specimen.
		*	Second specimen.
		0.0370	Third specimen.
		*	Fourth specimen.
10	1 1/12	0.039	First specimen.
		0.022	Second specimen. Tubercle bacilli in cerebrospinal fluid.
11	5½	0.0718	Tubercle bacilli in cerebrospinal fluid.
12	4	0.022	First specimen. Tubercle bacilli in cerebrospinal fluid.
		*	Second specimen.
13	3	0.0426	Tubercle bacilli in fluid.
14	8	0.0402	First specimen.
		0.0318	Second specimen.
		0.0298	Third specimen.
		0.03518	Fourth specimen. Tubercle bacilli in cerebrospinal fluid.
15	2	0.0351	First specimen Tubercle bacilli in fluid.
		*	Second specimen.
16	3½	0.0466	First specimen. Tubercle bacilli in fluid.
		0.0464	Second specimen.
17	8	*	Tubercle bacilli in fluid.
18	1⅓	0.038	First specimen. Tubercle bacilli in fluid.
		0.0240	Second specimen.
19	1¼	0.069	Tubercle bacilli in fluid.
20	5	0.059	First specimen.
		0.08	Second specimen.
		0.0588	Third specimen.
		0.0674	Fourth specimen.
		0.0606	Sixth specimen. Tubercle bacilli in cerebrospinal fluid.
21	4	0.0422	First specimen.
		0.0181	Second specimen. Autopsy. General miliary tuberculosis.
22	⅔	0.0422	First specimen.
		0.0261	Second specimen.
23	11	0.027	First specimen. Tubercle bacilli in fluid.
		0.0324	Second specimen.

* Too small to determine.

TABLE 4.—Cerebrospinal Meningitis, Miscellaneous Types

No.	Age Years	Disease	Dextrose Per Cent.	Remarks
1	1½	Pneumococcus meningitis	0.037	Five days' duration.
2	½	Influenza meningitis	*	First specimen.
			0.0214	Second specimen.
			0.022	Third specimen.
3	.....	Influenza meningitis	*	Moribund on admission
4	5½	Pneumococcus meningitis	0.0174	First specimen.
			*	Second specimen.
5	9	Streptococcus meningitis	0.0992	First specimen; fluid shows no cell or globulin increase.
			0.0718	Second specimen; seven cells per cubic mm.; no globulin.
			0.064	Third specimen; 156 cells; marked increase in globulin.
			0.0232	Fourth specimen; fluid cloudy; many pus cells.

* Too small to determine.

TABLE 5.—Sugar Content of Cerebrospinal Fluid in Poliomyelitis and Polio-Encephalitis

No.	Age Years	Dextrose Per Cent.	Remarks
1	5/12	0.063	Subacute stage. Anterior poliomyelitis.
2	5	0.0588	First specimen. Acute stage poliomyelitis.
		0.065	Second specimen.
3	.....	0.088	Chronic stage. Duration two weeks.
4	.....	0.0376	Acute polio-encephalitis. First specimen; 830 cells.
		0.0426	Second specimen; 750 cells.
		0.0398	Third specimen.
		0.0394	Fourth specimen; 170 cells.
		0.0395	Fifth specimen.
		0.044	Sixth specimen; 40 cells.

impossible to determine the possible influence of diet and other factors, which we know are capable of changing the sugar content of the blood. It is of great interest that the normal variation in the amount of sugar in cerebrospinal fluid is very close to that which obtains for blood. It therefore seemed of interest to ascertain whether there is any correspondence between the blood sugar and the cerebrospinal fluid sugar in the individual case. Accordingly, in ten cases we have made sugar determinations on blood and cerebrospinal fluid which were obtained at the same time. In only two instances were the values similar. These results indicate that although the variations in the blood sugar and the cerebrospinal fluid sugar are practically identical yet there is no correspondence in the individual case at a given time.

TABLE 6.—SUGAR CONTENT OF CEREBROSPINAL FLUID IN CEREBROSPINAL SYPHILIS

No.	Age Years	Dextrose Per Cent.	Remarks
1	.....	0.060	Case 3, Table 7, Wassermann positive on blood and cerebrospinal fluid. Idiocy.
2		0.059	Hydrocephalus. First specimen.
		0.0558	Second specimen.
		0.0592	Third specimen.
		0.0514	Fourth specimen.

Of interest are the results from four patients who were moribund at the time of examination. In three instances the dextrose value was very low; in one it was high.[11]

The Sugar Content of Cerebrospinal Fluid in Cases of Epidemic Cerebrospinal Meningitis.—Eight cases of meningococcic meningitis were observed and are described in Table 2. In common with the results of Connall, DuBois[12] and others we found that the reducing agent is usually greatly decreased. Connall states that the reducing power usually increases with improvement of the patient. This is well shown in Cases 1, 4, 5 and 8. In Case 6, however, there was a normal sugar value at the height of the disease and no increase

11. These cases are cited in Table 1, but can scarcely be considered normal.

12. Du Bois: Summary of Four Years of Clinical and Bacteriological Experience with Meningitis in New York City, Am. Jour. Dis. Child., 1915, ix, 1.

with improvement. Patient 7 showed an increase in the reducing action of the cerebrospinal fluid despite the fact that he became progressively worse.

The Sugar Content of Cerebrospinal Fluid in Cases of Tuberculous Meningitis.—A number of observations have been published concerning qualitative tests of the reducing power of cerebrospinal fluid in cases of tuberculous meningitis. The results are inconstant, but in a large percentage of the cases the fluid was capable of reducing copper salts (Connall, DuBois and others). In consideration of these results, our quantitative determinations are of special interest. (Table 3.) We found that in a single specimen of spinal fluid the dextrose percentage may be normal, slightly reduced or greatly reduced

TABLE 7.—SUGAR CONTENT OF CEREBROSPINAL FLUID IN CASES OF IDIOCY

No.	Age Years	Dextrose Per Cent.	Remarks
1	4	0.10	Idiocy and congenital syphilis.
2	.....	0.0692	Idiocy. Epilepsy.
3	11	0.061	Case 1, Table 6. Idiocy; syphilis.
		0.06	Second specimen.
		0.075	Third specimen.
4	.....	0.0514	Wassermann on blood positive; spinal fluid negative.
5	.....	0.066	Idiocy; spastic paraplegia.
6	.....	0.064	

and this variation could be traced to no definite influence. In most of our cases, however, there was a decrease in the sugar value at some stage of the disease and usually as the disease progressed. To this there were only two marked exceptions. In Case 1 the sugar was decreased at the time of the first tap but at the time of the third was normal. In Case 20 the sugar was normal during the entire course of the disease.

Miscellaneous Types of Meningitis.—Cerebrospinal fluid from two cases of pneumococcus meningitis, two cases of influenza meningitis and one of streptococcic meningitis were examined. In all the reducing power was greatly decreased or absent. Case 5 is of sufficient interest to cite. The patient, a boy of 8 years, was affected with septicemia due to streptococcus pyogenes. The first specimen of cerebrospinal fluid was normal in cell content, globulin and sugar.

The patient gradually developed symptoms of meningitis and with their progression the sugar content of the cerebrospinal fluid became less, and at the time when the symptoms were marked, was greatly reduced.

Poliomyelitis and Polio-Encephalitis.—In three cases of poliomyelitis the reducing power of the cerebrospinal fluid was normal. In one case of polio-encephalitis the sugar was decreased.

Idiocy. Congenital Syphilis.—Two cases of cerebrospinal syphilis and six cases of various types of idiocy were observed. In all the sugar content of the cerebrospinal fluid was within the limits of normal.

IV. SUMMARY

1. The reducing substance in cerebrospinal fluid is a fermentable, dextrorotatory sugar, probably dextrose.

2. In infants and children free from meningeal disease the cerebrospinal fluid sugar ranges from 0.05 to 0.134 per cent. (dextrose), approximately the same figures which obtain for blood sugar.

3. There is no decrease in the reducing power of the cerebrospinal fluid in meningism.

4. A large proportion of the cases of tuberculous meningitis show a decrease in the sugar content of the cerebrospinal fluid at some stage of the disease. In a few cases, however, the sugar is normal at all times or diminished but slightly. A decrease only is of diagnostic value.

Our material was obtained from the service of Dr. L. E. La Fétra at Bellevue Hospital. We desire to express our indebtedness for this privilege and for encouragement in the work. To Dr. Charles Norris, Director of the Pathological Laboratory, we are indebted for his kindness in placing the facilities of his laboratory at our disposal.

DISCUSSION

DR. HAND: I used to make quite a number of spinal fluid examinations myself, and became absolutely convinced that the reducing substance is a sugar for which Fehling's solution will sometimes fail to give the test in cases of tuberculous meningitis. In these cases, when tested by the phenylhydrazin method, I got the crystals of phenylglucosazone. I felt sure that it was a sugar, but did not carry the work out as scientifically as Dr. Schloss. I found the absence of sugar in suppurative meningitis, and its presence in practically every case of tuberculous meningitis; and I have depended on that, to a certain extent, in the diagnosis. When I found sugar in a case that was evidently one of meningitis, I persisted in examining the sediment for the tubercle bacillus. I was doing it with a technic somewhat defective; but I found the

bacilli in something over 90 per cent. of the cases. When I try to find the bacillus in these cases now, I find it more difficult, because I have lost my dexterity; but the presence of sugar in a case of meningitis should be a stimulus to make a persistent search for the tubercle bacillus. If such a search is made, it will be found in 90 per cent. of the cases.

That picture was striking. I might recall to the minds of the members of the society a note I made a few years ago, as to the explanation of the presence of sugar in these cases. It seemed to me that the germs had no influence on the presence or absence of sugar, but that this depended on the presence of polynuclear leukocytes. I made a little investigation, and found, using glucose as the sugar, that the polynuclear leukocytes would, within twenty-four hours, reduce the percentage of sugar materially. Those in the empyema fluid reduced sugar also, but to a slight extent. There seemed to be a ferment produced by the polynuclear leukocytes, which caused the disappearance of the sugar in the epidemic and suppurative forms of meningitis, and not in the tuberculous.

DR. HOOBLER: I should like to inquire whether Dr. Schloss and Dr. Schroeder were able to arrive at any definite prognosis, from the appearance of sugar in the spinal fluid of cases of the epidemic cerebrospinal meningitis type, that helped them in arriving at conclusions. I take it, also, that in the first line of Chart 3, five out of the eight examined were negative. These cases, of course, were uninfluenced by the treatment. In the treated patients could it be possible that the faint sugar reaction was due to the small quantity of sugar regularly present in the inoculated serum used in connection with the treatment?

DR. ABT: I should like to ask whether the essayists could explain the change in the permanganate solution, which is attributed by Meyerhofer to the presence of the sugar?

DR. SCHLOSS: With reference to the prognostic value of the presence of sugar in cerebrospinal meningitis, this has been pointed out by Connell, who states without equivocation that the appearance of sugar in the spinal fluid is one of the best indices of improvement. He found it true in all of a large series of seventy-five cases. In our small series we found this to be true to some degree. The patient, before receiving the serum, might show no sugar according to the quantitative method; but after the use of the serum, there was a perceptible rise in the sugar. In two or three cases, this rise in sugar was accompanied by marked clinical improvement, before there was any perceptible change in the number of cells and in the amount of globulin — which is in conformity with Connell's results.

With regard to the amount of the reducing substance in the serum, I doubt whether this would have any influence, although we made no experiments to see what influence it might exert. The reason that I take this view is that the serum was given in so small an amount, 10 c.c., and that the subsequent tapping was done eight hours, and often twenty-four hours, after the serum was injected. The normal sugar content of the serum was probably not more than 0.04 to 0.06 of 1 per cent., and the serum must have been well diluted by spinal fluid. Granting that the latter contained no sugar, adding this amount could not have given the figures we obtained.

In answer to Dr. Abt's question, I would say that I am not familiar with the method that he speaks of, and do not feel competent to make a reply.

ACUTE CEREBELLAR ATAXIA IN CHILDREN

REPORT OF A CASE WITH RAPID AND COMPLETE RECOVERY

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The condition about to be described appears to be an uncommon one. On this account it seems well to put the following case on record and to review the already published cases of a similar nature.

Susie R., aged 5 years.

History.—The family history showed nothing of importance. There were three brothers and one sister who were well. The patient had always been a healthy child, except for occasional attacks of bronchitis. There had been no illness of any sort in the household recently. On Monday, January 4, she suffered from cold in the head and a bronchial cough. An epidemic of influenza had been prevailing in the city. The symptoms continued on Tuesday, January 5, although the child was running around as usual. On Wednesday, January 6, she was worse, and Dr. William McCombs attended her for the next several days, and put her to bed. She had a heavily coated tongue, headache, and a temperature from 98 to 102. She continued about the same from January 7 to January 9, when her temperature had become normal. By Sunday, January 10, she was apparently quite convalescent, and was allowed to get out of bed. This day she was cheerful, playing, and seemed entirely well. In the evening, however, she complained of slight earache, from which she had never suffered before, but on Monday, January 11, she was up and about. Towards evening she began to complain that her hip hurt her, and she was hardly able to walk. On Tuesday, January 12, she vomited before she was out of bed. Later in the course of the morning she got up, but in the afternoon vomited several times and went back to bed. She still complained of her hip hurting, and any pressure on it seemed to make her shake all over. The mother noticed also that there was a jerking, irregular character to her speech. These were the first distinct nervous symptoms, and her mind seemed entirely clear. On the morning of Wednesday, January 13, the child was scarcely able to stand, and the mother now noticed the irregular movements of the eyes and eyelids. On this day she seemed dazed. Dr. McCombs described it as "a state of fear." She could not well be quieted, and in the afternoon her mental state became worse, and in addition she could not sit unsupported. About 9 o'clock in the evening she began to scream violently, sometimes for an hour at a time, almost without pause. This continued until 4 o'clock on the morning of the next day, January 14. She was pale and trembling; half delirious; there was apparently no disturbance of the tactile sensation, and she could feel wherever she was touched. After about two hours' sleep she started to scream again and was taken during the day to the Children's Hospital, four days after the onset of the acute symptoms.

Examination.—Examination on admission, January 14, showed a well nourished child of good color. The mind did not appear entirely clear, but there seemed to be no special excitability. She could utter a few words, but with great difficulty, and the speech was very jerking and irregular. There was a very high degree of lateral nystagmus nearly always present, but growing worse in paroxysms and increased on ocular exertion, and accompanied by a fluttering movement of the eyelids. The patellar reflexes were increased. There was a decided incoordination of the muscular movements of the extremities. A few mucous râles were heard in the lungs; respiration was regular. The heart showed nothing abnormal.

I made an examination of the child for the first time the next day, January 15, with the following notes: "The mental condition must certainly have improved, for it now seems nearly normal. She answers questions clearly, but after some delay and with a slight trembling of the voice. There is a curious, very marked fluttering of the eyelids which is not constant; and with this a rapid nystagmus, both lateral and vertical, lasting for a moment and then for a moment disappearing. No paralysis of the ocular movements can be found, and no facial paralysis. The child can whistle and show her teeth on demand. Her grip is good. There is trembling and a very decided ataxia in the movements of the arms and of the hands on attempted effort, apparently not increased by closing her eyes. The patellar reflexes are active, and there is slight ankle-clonus of the right foot, and a suspicion of this in the left foot. The Babinski symptom is absent. She can stand only when supported, and with her feet broadly separated from each other."

On January 16 and 18 Dr. Isaac Jones made careful examinations of the ears to determine whether the nystagmus was otitic in origin. The summary of his report reads as follows: Typical nystagmus and unbalancing of the control of the eye muscles are present. This is not due to any lesion of the ear, or any disturbance of the vestibular apparatus, because (1) spontaneous nystagmus on looking to the extreme right or left is decreased instead of increased; (2) the hearing is normal; (3) stimulation of the semicircular canals gives the correct normal nystagmus, controlling the oscillations and converting them into rhythmic nystagmus of a vestibular character, with a slow and rapid component. The nystagmus-circuit is, therefore, intact on both sides; indicating normal semicircular canals, eighth nerves, region of Deiters' nucleus, the posterior longitudinal bundle in the pons and its connection with the third and fourth nuclei, and, finally, the third and fourth nerves themselves.

On January 19 an ophthalmologic examination was made by Dr. H. M. Langdon, and the following report rendered: "Palpebral fissures about equal. In the right eye the pupil measures 4½ mm.; left eye, pupil slightly smaller. On admission of light, the accommodation is normal in each eye. The ocular rotation seems full and equal in all directions, the visual axes being parallel. The eyes are steady on fixation, but on rotation in any direction, there develop a few quick nystagmic jerks, usually about 5 or 6 oscilliations in a group, and then steady fixation will be resumed. The movements were usually accompanied by curious fluttering of the eyelids. The disks are slightly full, normal in color, with clear margins. There are no changes of the fundus."

Improvement went on with great rapidity. By January 23, nine days after admission, the child could sit up in bed unsupported, with some ataxic movements of the arms on attempting to balance herself. While standing on the floor there were some oscillatory movements of the entire body, but she could now walk if supported by one arm, and her gait was normal, except for a degree

of weakness and uncertainty. On closing her eyes she was unsteady, but not to a degree constituting Romberg's symptom. The grip was only fair, but equal on both sides. The patellar reflexes were slightly increased on the left side. No ankle clonus or Babinski reflex was present. The eyes exhibited a rotary nystagmus as observed before, but to a much less degree. The sensorium was entirely normal; the child answering questions and conversing freely, in contradistinction to the condition earlier in her history when, although she would answer questions, she made no effort to speak at other times. The tongue was protruded with ease in any direction. No facialis symptom could be elicited. She complained of her feet being constantly cold. She could feed herself fairly well and touch her nose with the eyes closed.

By February 1, seventeen days after admission, it was noted that she still walked with some unsteadiness, but without any support, and with the feet rather wide apart and the body bent somewhat backward in the effort to balance herself. The nystagmus had disappeared except on continued ocular exertion to the extreme of the ocular field. On February 10, one month after the onset of the acute symptoms, she was discharged from the hospital, and the following note was made: "Since admission there has been an entire change of mentality from sluggishness, haziness and dulness to a condition of alertness and brightness."

The temperature while in the hospital was afebrile, except for a rise to 100 on a single occasion. The Wassermann reaction taken on January 18 was negative, and the von Pirquet faintly positive. Lumbar puncture on January 21 gave a dry tap. The urine was examined on a number of occasions, and was practically always negative. On one examination a faint trace of albumin, cylindroids, an occasional hyaline cast and a few leukocytes were reported. Examination of the blood on the day of admission showed a leukocyte count of 11,600. The differential count gave polymorphonuclears, 57 per cent.; lymphocytes, 31 per cent.; mononuclears, 7.5 per cent.; transitionals, 3 per cent.; eosinophils, 1.5 per cent.; basophils, 0.

Treatment.—Treatment consisted on admission in the administration of a purgative and of sodium bromid. After this, on the ground that the condition might be toxic, bicarbonate of soda was given every four hours and enteroclysis every six hours. This treatment was continued until recovery was well advanced.

The noteworthy features in this case consist in the rapid development of symptoms without discoverable cause, unless possibly the child had suffered from influenza; the very uncommon degree of nystagmus; the ataxia of the extremities; disturbance of sensorium: affection of speech; slight increase of reflexes, and the rapid recovery, complete in one month from the onset.

We have here symptoms which, on the whole, point chiefly to some disorder of the cerebellum. That this was the only portion of the brain affected would seem questionable. As Batten[1] has pointed out in an able paper, it is impossible to draw a sharp line between the

1. Batten: Ataxia in Childhood, Brain, 1905, xxviii, 484.

cerebellar and the cerebral cases. In some the symptoms pointing to cerebral involvement predominate, and in others, as in the case reported, the cerebellar symptoms are in the ascendancy.

In the case I have described such systemic disorders as Friedreich's ataxia and the cerebellar ataxia of Marie were naturally out of the question. Tumor and abscess of the cerebellum, at first thought to be possibilities, were excluded by the course of the disease and by the examination of the eye-grounds; and that the nystagmus was not otitic in origin was shown by the application of Bárány's tests, although this was not certain proof that the symptom depended on a cerebellar lesion.

Fickler[2] gives a convenient classification of the diseases of the cerebellum, which may profitably be considered in the effort to place the case described. The first group is that of congenital cerebellar ataxia, from which this case is naturally excluded by the age. The second consists of the acquired cases, which are subdivided into the chronic progressive and the acute forms. The latter, to which this patient naturally belongs, is again divided into (a) traumatic, (b) encephalitic and (c) toxic. According to this classification the encephalitic cases follow especially the infectious diseases. The toxic cases would be represented in early life by those depending on gastro-intestinal auto-intoxication. The anatomic difference would appear to be that in encephalitis there is an actual inflammatory process active; and in the toxic cases the condition in the acute stage is one of cellular degeneration. Clinically it would seem difficult to make a sharp distinction, and the two may be conveniently grouped in this connection under the heading of acute nonsuppurative encephalitis, or acute hemorrhagic encephalitis.

The acute infectious diseases are the most frequent of the causes mentioned. In epidemics of poliomyelitis, too, cases are not infrequently seen with the symptoms of encephalitis, alone or in combination with spinal symptoms. The process in this disease is known to be an inflammatory one; and yet the recovery may be so complete in some instances that, in the absence of any other satisfactory explanation, the case recorded here might perhaps be assigned to this group; in this instance, most unusually, the cerebellum bearing the brunt of the attack. Against this supposition, yet not completely excluding poliomyelitis as

2. Fickler: Deutsch. Ztschr. f. Nervenh., 1911, xli, 306.

the etiologic factor, is the fact that nearly always the lesions in this condition are more widely disseminated than in the present case.

In the large majority of cases of uncombined acute hemorrhagic encephalitis the process is limited to the motor region of the cerebrum. In many it is seen also in, and in a very few cases it is confined entirely to, the region of the pons and medulla. In other cases, much less numerous than the first class, the encephalitis, as stated, attacks especially the cerebellum. In this event, there is the comparatively sudden development of the symptoms of encephalititis in general, such as fever, unconsciousness, convulsions, and the like, lasting a variable time; although in the end the cerebellar symptoms predominate. The most characteristic of these are ataxia, staggering gait and vertigo; although often associated, but not certainly cerebellar in origin, are nystagmus, disturbances of speech, and tremor.

The prognosis of the great majority of cases of acute nonsuppurative encephalitis, whatever the location, is favorable as far as life is concerned, and favorable, too, as regards improvement; but less so as regards complete recovery of power and of a normal mental condition.

Batten details several cases similar in many respects to the one I have reported, and publishes others collected from medical literature; and there are still a number of others not found in his series. I append abstracts of all the cases I have been able to discover. Only those are included in which the course of the disorder was sooner or later arrested and improvement followed. Those showing a progressive increase in the symptoms do not belong to this category.

CASES FROM THE LITERATURE

1. Shepherd (*Med. Times and Gazette, 1868, i, 144.*)

Girl, aged 5 years. On the second day of scarlet fever she became speechless. Examination a month later showed her unable to speak, write or stand; her head and arms fell forward; her legs were weak. After three weeks she improved rapidly and could walk, although with an ataxic gait. Gradually she became more intelligent. In about three and one-half months from the onset she could play about the ward, although her movements and speech were far from normal.

2. Schepers (*Berl. klin. Wchnschr., 1872, ix, 517.*)

Girl, aged 8 years. On the fourth day of measles she became unconscious, and later exhibited aphasia and then marked ataxia of the limbs. The intelligence seemed unaffected; the sensibility normal. In one and one-half months she began to speak, but with an altered voice; she could stand supported, but not walk; there was great ataxia in the hands. A week later she walked with

an ataxic gait. Memory had been largely lost, but she learned rapidly, and several months later rejoined her original class in school. Schepers speaks of the favorable outcome, but does not state whether any traces of the disorder remained.

3. Feith (Allg. Ztschr. f. Psychiat., 1873-4, xxx, 236.)

Boy, aged 5 years. Typhoid fever was followed by aphasia, ataxia and unconsciousness. After three weeks improvement took place in the mental state, but he still could not stand. Later he had psychic disturbances and a distinctly ataxic gait, and this condition lasted three weeks. About two months after the onset he seemed to have recovered completely. No reference is made to any ataxia of the upper extremities.

The fourth case is the only one in the series following trauma. The question could be raised whether it should properly be included here, inasmuch as the ataxia was of slower development than in the other instances. It seems to me, however, rapid enough to be called acute.

4. Bastian (Lancet, London, 1878, ii, 207.)

Girl, 10 years of age. She fell down stairs striking occiput; experienced no loss of consciousness, but suffered from pain in the head on the next day. Two weeks later she had another fall on the occiput. After this she grew worse, and in two weeks was having vomiting and occipital pain. She was sent to the hospital eight weeks after the first fall. One week later, when attempting to get out of bed, she was found to stagger badly. Soon after this the sight became impaired. When seen again six months after the first accident she had a drunken gait; incoordination of the hands; optic neuritis; pain in the head; normal intelligence. She grew worse for a time, but after about three months improvement began, and in two months more she had perfect power in the upper extremities. By about a year after the fall she was entirely well, except a slight affection of gait.

5. Lenhartz (Berl. klin. Wchnschr., 1883, xx, 312).

Boy, 8 years of age. Acute dysentery was followed promptly by a brief maniacal state, and then entire loss of speech; anesthesia; paralysis of the sphincters, and mental weakness. Two weeks later he had nystagmus and marked ataxia of the head, extremities and trunk. The aphasia and ataxia lasted for months, and he could not speak for three months. At the end of two and one-half years there was only a little ataxia and slowness of speech and a deficiency in intelligence.

6. Hammarberg (Nord. med. Arkiv., 1890, xxii, No. 23).

Male, aged 7 years when he had pertussis, and soon after this "inflammation of the brain," with unconsciousness for a short time. This was followed by rhythmic swinging movements of the head; incoordination of the arms; loss of speech; inability to walk, and mental disturbance for a short time. The condition remained unchanged for three months, and then gradually improved. About one year after the onset the ataxia had lessened and he could walk unaided, but the gait was uncertain and reeling. The patient finally returned to school, but his gait continued to be always uncertain; the speech scanning and slow; he could not write well, and his disposition was altered for the worse. At the age of 22 years he had inflammation of the lungs, and after this gradually became insane and died at the age of 24 years.

7-9. Lüthje (Deutsch. Ztschr. f. Nervenh., 1902, xxii, 280.)

Three cases occurring in one family, all developing during severe typhoid fever.

7. Boy, 10 years of age. Unconsciousness developed on the fifth day of the fever. This persisted for seven weeks, and afterwards he remained dazed for over a month more and could not speak. During this time there were rhythmic movements of the head. When discharged from the hospital four months after the onset he could walk only with support; had ataxic movements of the legs and of the left arm; disturbance of speech, and ataxic nystagmus.

8. Girl, 7 years of age. Had unconsciousness for weeks, with oscillatory movements of the head, grinding of the teeth and twitching of the face. She gradually improved and then showed decided ataxic movements of the extremities. Two and one-half months after the onset there were still imperfect speech, marked ataxia of extremities, unsteady gait, active tendon reflexes, and ankle-clonus. The sensibility was not affected, and there was no nystagmus or psychic disturbance. Three weeks later the gait and speech were still affected, but the upper extremities were normal.

9. Boy of 6 years. He had a dazed condition for one and one-half months, and did not speak for two weeks more. Meantime there were rhythmic movements of the head, and marked ataxia of the trunk and extremities. No effort to speak was made until after one and one-half months, and then the speech was slow and scanning. He improved rapidly, and about two months from the onset he had remaining only a slight disturbance of speech and of gait.

Lüthje summarizes the principle symptoms of all three cases as follows: Severe typhoid fever followed by unconsciousness lasting for weeks; gradual recovery of mentality; severe ataxia in all the muscle groups, without paralysis or disturbance of sensation; slight disturbance of intelligence affecting the memory; scanning speech and increased reflexes.

10. Taylor (Lancet, London, 1904, ii, 1416).

Boy, aged 4 years. Six weeks before he was admitted to the hospital he had a slight fall, but without striking the head; three weeks later he had pertussis; four days before admission he developed twitching of eyes, hands and feet, and was unable to walk. Examination showed trembling of the limbs and the trunk, suggesting disseminated sclerosis; inability to speak plainly or to walk alone; nystagmus. In twenty-two months he could walk with a drunken gait when supported; the arms were ataxic; the speech hesitating; the mental condition good. By three and one-half years after the onset he was reported to be nearly well, although the speech was still a little imperfect. Examination over twenty years later showed the recovery complete.

11. Voelcker (Brain, 1905, xxviii, 360).

Girl, aged 4½ years. Scarlet fever was followed by unconsciousness lasting two weeks; no vomiting. Then the speech was found to be lost and she could not feed herself. Improvement gradually followed, and when examined three months later she could not stand; the gait was ataxic when supported; there was some ataxia of the upper extremities; tremor of the head; brisk knee-jerks; variable plantar reflexes; no ankle-clonus; slow and indistinct speech. Two months later (five months after the onset) she showed little improvement; the knee-jerks were less active; the ataxia less; the mental condition improving. One and one-half months after this the symptoms were still very marked.

12. Guthrie (*Brain, 1905, xxviii, 363*).

Girl, 7 years of age. During measles there occurred vomiting, convulsions, squint and unconsciousness. After five days she was better, but could not speak. Aphasia persisted, and there developed exaggerated knee-jerks; incoordination of upper and lower extremities; anesthesia and loss of sphincter-control. She improved gradually, and in three months could stand, talk and feed herself. Sixteen months after the onset there were drawling speech; slight ataxia; tremor of the upper extremities; ataxic gait; brisk knee-jerks; ankle-clonus at times. She was mentally slow.

13. Batten. First Case. (*Brain, 1905, xxviii, 489.*)

Girl, aged 4½ years. Immediately after influenza she developed vomiting, and in a week paresis of the legs and affection of speech; slight involvement of the sphincters; no loss of consciousness, and never headache. A month and a half later she showed a wildly ataxic gait when supported, and could barely stand alone. There were marked incoordination of the hands; somewhat bulbar articulation; slight paresis of the left side of the face; active knee-jerks; doubtful ankle-clonus. There was no nystagmus. Examination three months after this showed that recovery was complete.

14. Batten. Second Case. (*Ibid., 490.*)

Boy, aged 3½ years. Measles was followed by convulsions and unconsciousness lasting a week. Two months later there were slow speech; marked ataxia of the arms and legs; slight ankle clonus, and perverted moral sense. There was no nystagmus. After one and one-half years he was very much better. When seen last, April 1907 (Clin. Soc. Trans., 1907, xi, 276), there was still slight incoordination of the legs, although the gait was good; the speech was rather slow and hesitating, and the mental condition rather backward for the age.

15. Batten. Third Case. (*Clin. Soc. Trans., 1907, xi, 276.*)

Boy, aged 11 years. Without known cause he developed headache, and on the next day falling; inability to feed himself, and vomiting. On the sixth day he had a drunken gait; ataxia of both legs, but less in the hands; nystagmus; active knee-jerks; loss of tone in the limbs; no affection of sensation. He improved rapidly and in a little over three weeks showed only slight ataxia of the lower extremities.

16. Batten. Fourth Case. (*Ibid., 277.*)

Boy, aged 12 years. He had had petit mal for some years. After a severe attack he suffered from unconsciousness for three days. Following this there were no control over the arms or legs; slow and jerking speech; unsteadiness of the trunk and head; poor mental condition; intention-tremor; no vomiting or headache. He had not been able to walk for over six months and when aided had a wildly ataxic gait. The knee-jerks were active. He improved but little while under observation.

17. Nonne (*Neurolog. Centralbl., 1909, xxviii, 885.*)

Boy, aged 12 years. During an epidemic of poliomyelitis he developed an encephalitis with cerebral symptoms, especially jacksonian epilepsy, and subsequent hemiplegia. He was unconscious for a week. After subsidence of the cerebral symptoms, he showed general disturbance of coordination, affecting even speech and the muscles of respiration. In the course of two months the symptoms subsided, and in three months he was completely well.

Among more than doubtful cases not included in this series may be mentioned the following:

Marie and Joltrain (Rev. Neurolog., 1910, xx, 123.)

Boy, 14 years of age. He had typhoid fever at 5 years, followed by difficulty in speech, in walking, and in some of the movements of the extremities. The condition steadily grew worse. There was marked ataxia with complete abolition of reflexes. The mental state was normal.

This case, although beginning apparently acutely, had shown such a progressive increase of symptoms, that it is rather to be placed in the category of "chronic progressive ataxia."

Baudoin and Francais (Rev. Neurolog., 1910, xx, 139).

Girl, aged 7½ years. Epileptiform seizures began at 3 months and continued with irregular and increasing frequency. When examined by the writers at 7½ years of age the intelligence was little developed; she could express herself very imperfectly; there were slight increase of the knee-jerks on the left side; some hesitation and trembling in the upper and lower extremities, and a cerebellar gait. There was no nystagmus.

The doubt in this case is principally as to the acuteness of the origin, which may, in fact, have been congenital.

Williamson (Proc. Royal Soc. of Med., 1912-13, Sect. on Dis. of Ch., 41).

Boy, 10 years of age. Tremor began 3½ years before, and the child lost strength and grew less bright. Examination when brought to the hospital showed tremor in the arms and tongue; ataxic gait; brisk knee-jerks; no nystagmus. Seven months later there had been no marked progression of symptoms. A doubtful slight lateral nystagmus was present.

Williamson says that juvenile paralysis could be thought of in the diagnosis. There is nothing in his history indicating an acute onset, and the case hardly belongs here.

ANALYSIS AND CONCLUSIONS

The following analysis and conclusions may be formulated based on the 18 cases including my own. They are necessarily incomplete, owing to the absence of sufficiently full details in some instances.

The immediate apparent causes of the attacks in the cases as reported are divided into: scarlet fever, 2 cases; measles, 3; typhoid fever, 4; pertussis, 2; influenza, 1; poliomyelitis (?), 1; epileptiform convulsions, 1; trauma, 1; dysentery, 1; not discovered, 2. Possibly my own case, placed in the last class, could with reason be assigned to influenza. The preponderance of acute infectious diseases is very

evident. Only one case followed trauma. It does not appear that the pertussis reported in two instances was of sufficient severity at the time to put these cases in the class of traumatism from violence of coughing; but possibly the case following epileptiform convulsions could be placed here. The instance of an attack following dysentery might possibly be an example of ataxia of toxic origin, but the duration was almost too long to permit of this conclusion. Ten of the patients were boys; 8 girls. The age at the time of onset ranged from 3½ years to 12 years; 10 of the patients being 6 or more years of age.

That the condition present is in fact dependent on a lesion of the cerebellum is, in a way, an assumption. Only in the patient seen by Hammarberg did the case come to autopsy, and here very serious alterations of the cerebellum were found. This, however, was years after the first appearance of symptoms, the patient meanwhile having become insane and developing new somatic disturbances; and to how great a degree the early acute manifestations depended on the lesions found must remain uncertain. The complex of symptoms based on the composite of all the cases seems sufficient, however, to warrant a belief in the cerebellar origin. That the malady is not dependent on vestibular or labyrinthine disease was shown in the case now reported by the application of Bárány's tests, and in none of the patients was any impairment of hearing noted. Vertigo, so characteristic a cerebellar or labyrinthine symptom, is not referred to in any of the reports. The early age of most of the patients makes the identification of this symptom a matter of difficulty.

Disturbances of the sensorium were present in the early stages of a large number of cases. Unconsciousness is mentioned in 11 instances, sometimes of brief duration, sometimes lasting for weeks. Convulsions were occasionally seen; delirium was also observed. All these may be classed among the symptoms common to any severe intracranial lesion; or they might be the evidence of a complicating disturbance in other regions than the cerebellum. Some affection of mentality, apart from unconsciousness, was present in 12 instances. In most of these it was of brief duration, but in a few it persisted in some form for a longer time. In such it, of course, indicated lesions elsewhere than in the cerebellum alone. Regarding the disturbance of speech, it is interesting to observe that in 8 cases the patient was for a time entirely unable to speak, and in some instances this condition lasted for months. Later, after the power to speak had been regained, in all but 3 of the

cases some affection of it remained for a variable time, and in many was still present when the patient was last seen. It is described as "slow," "drawling," "scanning," "jerking," or "irregular." The affection of speech might with propriety be considered an extracerebellar disturbance; but certainly in some cases at least, and perhaps in most of them, seems not so much to depend on an involvement of the centers for speech, as on an inability to articulate properly, an ataxic condition. It is possible that in producing the speech-disturbance the medulla may also be involved, and the same is true of the vomiting, which was seen early in some of the cases.

The tendon reflexes were found "brisk" or "increased" in 9 instances. In the others nothing is said on the subject. Ankle-clonus was present in 4 cases. It is evident, then, that there is a distinct tendency to increase of the reflexes in this disorder, pointing toward the cerebellar involvement. In a few cases "weakness" or "hypotonia" of the limbs is mentioned, but in others it is distinctly stated that no weakness or paralysis was discoverable. In general, it is a fair conclusion that the inability to walk or to use the arms depended on the ataxia rather than on paresis. The ataxia was noted in every instance; in the legs in all, in the arms it appears to have been present in all but 1 case. Not infrequently the trunk and the head shared in the incoordination. Anesthesia is mentioned in 2 instances, and more or less loss of control of the sphincters in 3. These symptoms are, of course, not cerebellar. It is to be observed that nystagmus is recorded in but 5 cases; apparently in none of the others as marked as in my own patient. Although it is probable that there exists a cerebellar nystagmus, the symptom is certainly produced by lesions of other regions as well; and this series shows how frequently there may be a cerebellar ataxia without nystagmus. Optic neuritis was seen in but one instance.

That the lesion is one capable of partial or even complete removal or compensation is shown by the history of the majority of the cases. In 7 it is stated that entire recovery ensued, and it is probable that Scheper's case is to be included here, although the text is not quite clear. In my own patient recovery was complete in one month from the onset of the attack; in Feith's case in 2 months; in Nonne's case in 3 months; in Batten's first case the patient was found well in 4½ months. The case of Taylor is of especial value from a prognostic point of view. After 3½ years following the onset there were still slight evidences of the disease present, but when seen over 20 years later recov-

ery was complete. In a number of the cases reported the time which had elapsed during which the patient was under observation had been short, and the improvement had been rapid; and it is a fair presumption that many of these recovered completely. There is, indeed, every reason to believe that in many instances few if any evidences of the disease will remain. That, however, severe symptoms may persist a long time and probably always, is shown by at least 8 of the cases, and in some of these unfortunately some intellectual or psychic abnormality remained.

FOREIGN BODY PNEUMONIAS

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In 1914, during my four months' service at the New York Post Graduate Hospital, I had an opportunity of observing the behavior of foreign bodies in the deep respiratory tract in three cases, the clinical features of which are of sufficient interest to warrant a brief report.

Two of the cases were sent to the wards with an outside diagnosis of "unresolved pneumonia," and without the suspicion of a foreign body in the lungs. The third case came with a foreign body history.

CASE REPORTS

Case 1.—Morris V., aged 2 years and 10 months, became sick four weeks previous to admission with chills, fever, vomiting, cough and dyspnea. These symptoms were observed and charted during the first few days of the child's stay in the hospital; also it was observed that pus was occasionally coughed up. The temperature chart shows fever up to 104 F. with daily remissions to normal. The routine clinical examination which included von Pirquet and Wassermann tests, was negative, except as follows:

The blood examination showed moderate leukocytosis and a moderate increase of polynuclears. There was dulness on percussion over the entire right lung posteriorly and in the right axilla. Dulness was most marked at the base. Breathing sounds and voice were indistinct at base. Needle aspiration in dull area was negative as to fluid.

The spasmodic character of the cough, the expectoration of pus in an acute lesion, in the absence of amphoric breathing such as we find in cavity formation, gave rise to the suspicion of a foreign body irritation. The roentgenogram, of which I show you the print, reveals a large tack, with a large round head in the right lung. Our bronchoscopist, Dr. Forbes, tried to remove the nail with the aid of the bronchoscope and a long slender forceps on April 24 and failed at the first attempt. Four days later a second attempt, guided by the fluoroscope, was successful. Rapid improvement followed the removal of the tack; the physical signs cleared up and the child was discharged cured. The tack had been lodged in the lung about five weeks.

Case 2.—Eva B., aged 2 years, was admitted April 1, 1914, with the following history: Pneumonia one year ago; diphtheria three months ago. There was no resolution following the attack of pneumonia. And the child's troublesome spasmodic cough persisted throughout the year. During the first few days of the child's admission the temperature ranged from normal to 103 F.

The routine clinical examination, which included the Wassermann test, was negative excepting as follows:

The von Pirquet reaction was slightly positive; the blood examination showed secondary anemia. Percussion over the left chest anteriorly gave an almost flat note; posteriorly there was dulness to flatness from apex to base. Over the right lung posteriorly the percussion note was impaired. On auscultation over the left lung anteriorly many coarse and subcrepitant râles were heard. Bronchial to tubular breath sounds were heard over the left chest posteriorly, with numerous crepitant coarse râles. Over anterior and posterior right chest a few coarse râles were heard. No pus was found on puncture. Without loss

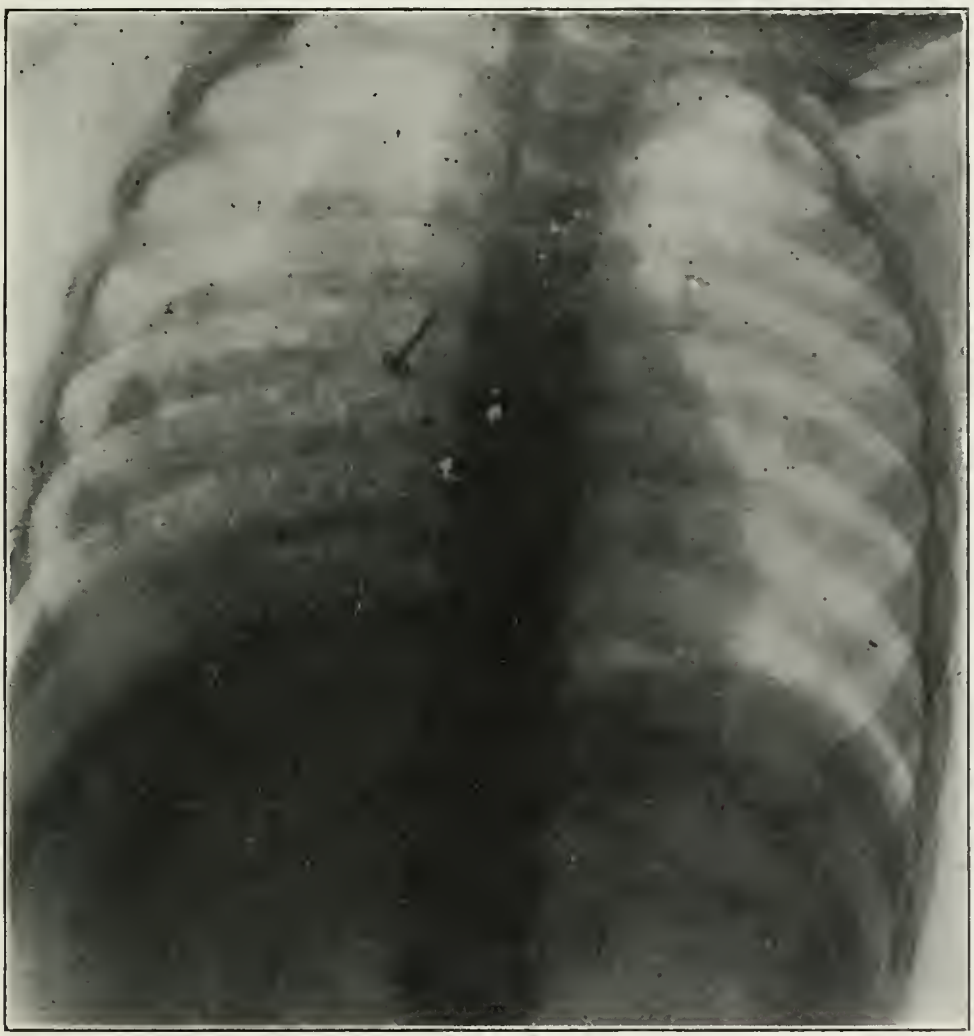

Fig. 1.—Large tack in consolidated right lung.

of time a Roentgen-ray examination was made, the roentgenogram, of which I present a copy, shows a large nail in the left bronchus and partly in the trachea. The first attempt to remove the nail with a bronchoscope and forceps failed. After this operation breathing became noisy and croupy and in intervals considerable yellow, foul smelling pus was coughed up, after which the temperature dropped to normal.

On April 14 a low tracheotomy was performed and Dr. Forbes succeeded in engaging and removing the nail with the aid of the bronchoscope. By the

following day, April 16, an extensive pneumonia had developed with temperatures up to 105 F., pulse 140, respiration 66, and the child died on April 17. In all probability the nail had been in the child's lung for over a year.

CASE 3.—John L., aged 4, was admitted to the hospital April 6, 1914, and discharged May 15, 1914. The history given by the mother was as follows:

Three days before admission to the hospital the child had "swallowed" a shawl pin. During the night the child complained of pain in the chest, but

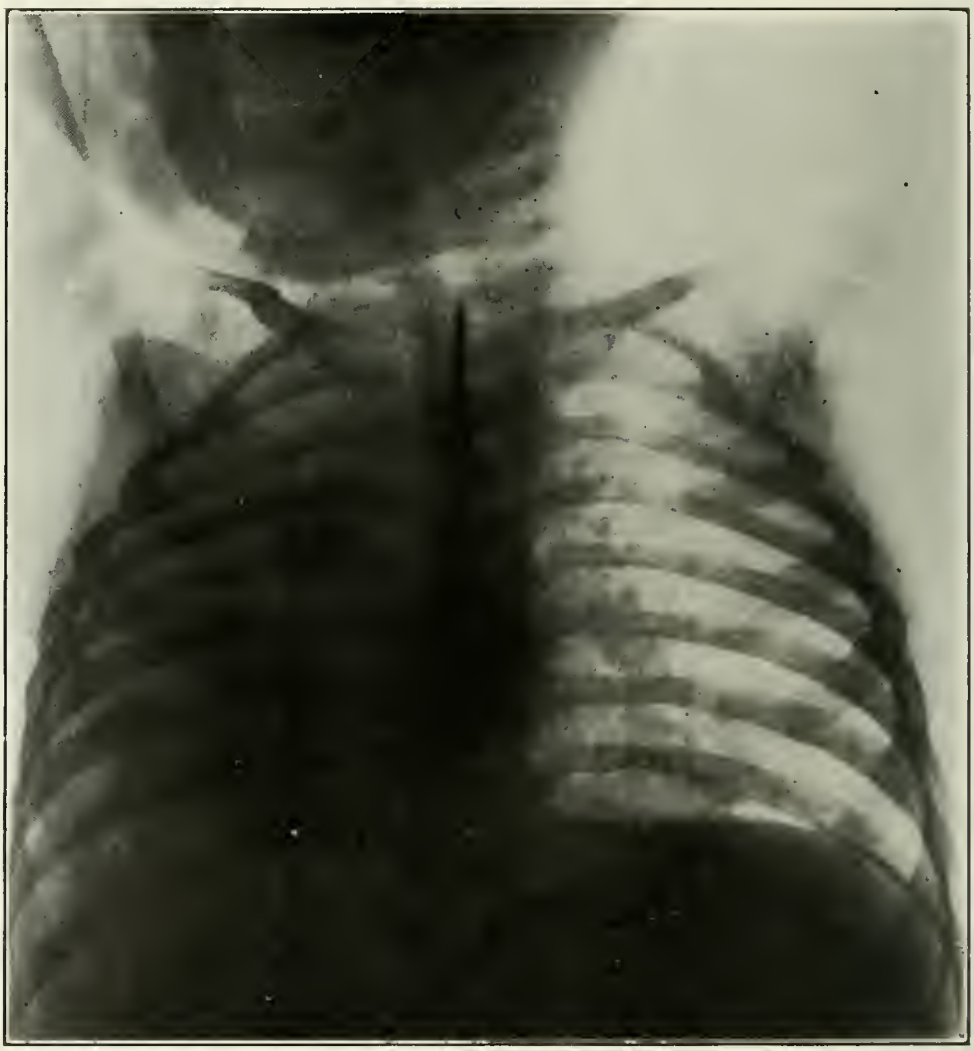

Fig. 2.—Large nail in consolidated right lung and in bronchus.

otherwise was apparently comfortable. He ate regularly and had normal bowel action; the stools had been watched but the pin had not appeared.

On admission to the wards the boy was found to be well developed and well nourished. His tongue was clean and moist, heart and lungs were normal, no adventitions breath sounds, slight cough, abdomen negative, temperature 99.4.

A roentgenogram made the following day, of which I show you a print, reveals the shawl pin in the left bronchus, the point projecting at the bifurcation in the trachea.

An attempt was made to remove the foreign body with the aid of the bronchoscope, but was unsuccessful. Following this procedure the temperature rose to 104 F. and for two weeks an irregular fever persisted. During the febrile period it was deemed wise not to subject the child to further manipulation with the bronchoscope.

On May 7 a second roentgenogram was made which gave the same picture as the first, and showed no evidence of infiltration around the foreign body. On May 12, one day previous to the date fixed on for a second exploration with

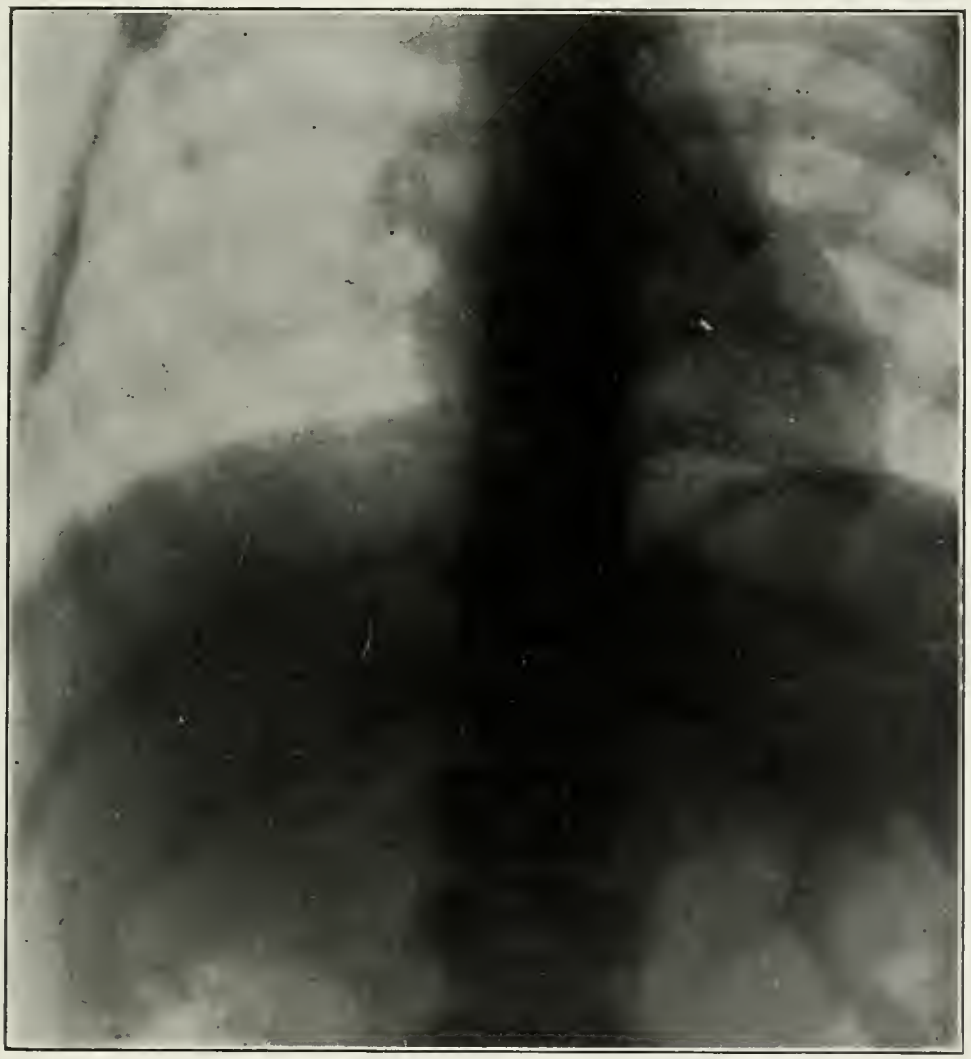

Fig. 3.—Shawl pin in nonconsolidated left lung.

the bronchoscope, the child during a severe spasmodic coughing spell coughed up the 2½-inch long brass shawl pin.

The boy went home in perfect health. The pin had been in the child's lung forty-three days without inducing local inflammation.

Young children have a habit of putting things into the mouth and not infrequently we encounter cases in which foreign bodies such as whistles, coins, safety pins and so forth, are retained in the gullet or in the upper respiratory tract.

Mothers and nurses in many instances have a habit of holding safety and stick pins in the mouth, thus teaching this dangerous practice to their children by suggestion. As a rule patients are brought to the physician with a foreign body history, and with well known acute symptoms.

In two of the cases here presented neither the mother nor the family physician suspected a foreign body as the cause of the pneumonia. Had these cases not been transferred to institutional care with its modern equipment, in all probability both would have perished with a verdict of death from pneumonia. These cases also show the great value of the Roentgen process as an aid to diagnosis, and the value of bronchoscopic methods.

The following deductions seem warranted:

1. All cases of unresolved pneumonia and cases of pneumonia of atypical behavior should have roentgenograms.

2. All foreign body cases should be publicly reported in the lay press as a warning to those having charge of young children to keep things out of reach and not to teach dangerous practices by direct suggestion.

DISCUSSION

DR. GRAHAM: Dr. Caillé's paper impresses on us a most important fact, which has only within the last two or three years been called to my attention; and that is that there is a possibility of foreign bodies gaining access to different portions of the lung, without their presence in the respiratory tract being suspected. I have the records of two cases that would fall under the category of the title of Dr. Caillé's paper. In none of them had the presence of the foreign body been suspected. In other words, the child was sent into the hospital for an obscure pulmonary condition; and had it not been for the examination made with the Roentgen ray, the condition would not have been thought of. I think that the paper is, if for no other reason, extremely valuable because it calls the attention of the profession at large to this possibility, which certainly, in my experience, has only recently been impressed on us.

DR. MILLER: In connection with the third case that Dr. Caillé reported, I would say that about nine years ago there was in my wards at the Children's Hospital, Philadelphia, a child of tender age who had a history of a very spasmodic cough lasting several weeks. Before its admission, it had developed fever. On examination we found, at first, only coarse râles and irregular fever. Later, however, the signs of lobar pneumonia developed on the right side, with quite a high temperature, rather fluctuating. The only peculiarity about the case was the spasmodic cough. On the fourth or fifth day of the pneumonia, the child, in one of its coughing attacks, brought up a tack similar to one of the pictures shown by Dr. Caillé. After this there was a rapid defervescence and recovery. At no time was there purulent expectoration or any evidence

of the existence of an abscess or of any mechanical injury to the lung. The case was so much the counterpart of one of those reported by Dr. Caillé that I have mentioned it at this time.

DR. KOPLIK: I wish to call attention to a physical sign that in some cases is present before the Roentgen ray would be thought of. This is a peculiar snarling sound just over the division of the bronchi. In such a case, the child came in with spasmodic cough, and the diagnosis of the possible presence of a foreign body was made. We found a tag that had gained entrance to the trachea.

Another point that I wish to speak of is that if we do not find a foreign body by means of the Roentgen ray, we should think of the fact, if we have a history of something swallowed, followed by a sudden cough of a spasmodic nature, that the foreign body may be a bean or some other small piece of vegetable substance; because these do not show in the Roentgen-ray plate. In one case, the roentgenologist said that there was nothing in the chest and we discharged the boy. Six months later, however, he came back. He was then bronchoscoped, and a bean was found right in the lumen of the bronchus. If we fail, in the case of a child with a history of the sudden onset of spasmodic cough, to find any foreign body by means of the Roentgen ray, we should use the bronchoscope and see whether there is any vegetable substance there.

MENINGITIS IN THE NEW-BORN, WITH REPORT OF A CASE

CHARLES HERRMAN, M.D.
NEW YORK CITY

Meningitis in the new-born is rare. In an incomplete search through the literature I have been able to collect only 8 cases with post mortem and bacteriologic examination. Two of these (Reuss, De Bruin) are only mentioned as having occurred without any further details.

Scherer: Jahrb. f. Kinderh., 1895, xxxix, 1. The patient was admitted to the hospital when nine days old. Mother healthy and had plenty of breast milk. Infant very weak, jaundiced. Lost rapidly in weight, had vomiting, diarrhea. The temperature ranged between 38 and 40 C., but on the day of its death, when eighteen days old, the temperature was normal. There were a few râles in the chest and the abdomen was distended. *The diagnosis was acute gastro-enteritis.* Postmortem examination showed a thick, yellowish-green, purulent exudate covering the convexity and base of the brain. Similar pus was found in both ears. Bacterial examination of the meningeal exudate: Bacterium coli.

Hinsdale: Lancet, London, 1899, p. 1030. A new-born died on the thirteenth day. The mother had uterine trouble. The infant was emaciated, continued to lose weight, had convulsions, nystagmus, retraction of the head and a temperature of 103 F. The umbilical cord was fetid. Postmortem examination showed a purulent exudate covering the surface of the brain. Bacterial examination: *B. coli.*

Scheib: Prag. med. Wchnschr., 1900, p. 169. An infant eight days old, one of twins, died *without any special symptoms,* the *diagnosis* being *congenital debility.* Postmortem examination showed purulent meningitis, purulent otitis, atelectasis. Bacterial examination of the meningeal exudate showed *B. lactis aerogenes.*

Goldreich: Jahrb. f. Kinderh., 1902, lvi, 808. An infant *asphyxiated* at birth had convulsions twenty-four hours later. Jaundice, cyanosis of the lips and extremities, a prominent anterior fontanel, diarrhea, irregular respiration, a weak heart, some retraction of the head and a temperature of 37 C. (98.6 F.). It died twenty-four hours later. Postmortem examination showed an acute fibropurulent meningitis, a purulent pleuritis, bronchitis. The nose, ears and navel were normal. Bacterial examination: *B. coli.*

Benfey: Med. Klin., 1907, xl, 1199. A new-born on the seventh day refused to take the breast and had a slight spastic condition of the jaw and of the extremities, convulsions, Cheyne-Stokes respiration and a temperature of 37.8 C. (100 F.). Died on the following day, the temperature rising before death to 40 C. (104 F.). Postmortem examination showed a suppurative meningitis. Bacterial examination: *B. pyocyaneus.*

Bonhoff and Esch: Ztschr. f. Geburtsh. u. Gynäk., 1912, lxx, 886. An infant 9 days old showed a slight rise of temperature. On the eleventh day the temperature rose to 39.8 C. (103.8 F.), and it died with convulsions on the fourteenth day. Postmortem examination showed a purulent meningitis and otitis. Bacterial examination: *Bacterium mucosus capsulatus.*

My own case was as follows: J. F., born in the Lebanon Hospital, Nov. 13, 1914; morphin-scopolamin amnesia. The mother is healthy and has two healthy children. The labor was easy, not protracted and noninstrumental; the baby was not asphyxiated and weighed 5 pounds, 6 ounces at birth. It was breast fed and while in the hospital presented no unusual manifestations. Mother and baby left the hospital on November 25, the latter weighing 5 pounds, 8 ounces. On the day following the baby refused to take the breast; there was constipation and retention of urine. It was admitted to my service on November 29. On examination it was found that the infant was somewhat cyanotic, limp and apathetic. The physical examination showed nothing abnormal; there was no vomiting, no prominence of the anterior fontanel, no retraction of the head, no spasticity of the extremities, in fact no symptoms which would have suggested the possibility of meningitis, so that a lumbar puncture was not made. At 6 p. m. the temperature was 96, at 9 p. m. 96.2, at 12 p. m. 96.4; from that time the temperature became so subnormal, notwithstanding the application of hot-water bags, that it could not be registered on the clinical thermometer. The child became more cyanotic, the breathing became irregular and it died at 5 p. m. on November 30.

Postmortem examination by Dr. Riegalman, coronor's physician, showed a female infant fairly well nourished, abdomen somewhat distended. On opening the skull a thick, yellowish-green exudate was found covering the anterior surface and the base of the brain. This exudate was not uniformly distributed, but was more distinct at certain points. There was an increased amount of fluid in the ventricles. The exudate appeared to extend to the cord. The thymus was small, about the size of a lima bean. Heart and lungs normal. Stomach dilated and contained a few curds of milk. Liver, spleen, kidney and intestine normal. Unfortunately, no special examination of the ears or nasal sinuses was made. Microscopic examination of a section of the brain covered by the pyogenic membrane showed that the parenchyma was infiltrated with numerous round cells and the vessels were injected. The lungs were congested and many air vesicles were filled with blood and endothelial cells. The thymus, stomach, liver and spleen showed nothing abnormal. Cultures made from the meningeal exudate showed the pneumococcus (Dr. Bernstein).

The case is interesting because, as far as I could ascertain, it is the only case of pneumonoccus meningitis in the new-born reported; on account of the absence of fever and later the marked subnormal temperature; and on account of the entire absence of meningeal symptoms, so that the necessity for a lumbar puncture was not even thought of.

The primary infection in these cases of meningitis in the new-born may take place: first, through the placental circulation. This is prob-

ably exceedingly rare, since the normal placenta acts as a filter and usually prevents the passage of infectious material. It is only when it is diseased or partially detached that such material enters the fetal circulation. Second, in cases of difficult labor there may be premature respiration of the infant (in utero) resulting in the swallowing or aspiration of contaminated amniotic fluid. This is most likely to occur in partially asphyxiated infants and when there is a premature rupture of the amniotic sac. Third, infection may take place at birth through an injury to the skull. Fourth, after-birth infection may take place through the eyes, nose, throat, ears, gastrointestinal tract, umbilicus or genitals. From the fact that the Bacterium coli is the most common causative agent in these cases, it is highly probable that the infection frequently takes place through contaminated water in the bathing tub. These organisms entering the nose, throat or ears may cause an otitis or sinusitis which may result in an infection of the meninges; in some cases the infection of the meninges probably takes place through the circulation, for example in Hinsdale's patient in whom the primary focus was in the umbilicus. The frequency of otitis in these cases is worthy of special mention. A number of authors (Tröltsch, Wreden, Netter and Rasch) have called attention to the fact that otitis is found postmortem in a very large percentage of infants dying from various causes in whom no indication of involvement of the ears was present during life.

250 West Eighty-Eighth Street.

DISCUSSION

DR. SEDGWICK: Meningitis in the new-born is more common than the literature of the subject indicates. The reason for this is fundamental, and is one that this organization and others should consider. I have inquired, and have found no teaching institution in this country, except Minnesota University, where new-born babies are directly in charge of the pediatric division. There may be such an institution, but such an arrangement is not common. We have it at the University of Minnesota. As pediatrists all know, the new-born baby, when in charge of the obstetrician, is merely considered as a "by-product." There is little or no routine physical examination made of the new-born babies, and my obstetrical friends in Minneapolis admit that these infants are usually left to the care of the nurse. In the hospital connected with the University of Minnesota, we make thorough and repeated examinations of new-born infants, who are turned over to us immediately, and are not in charge of the obstetric department at all.

There are many interesting conditions found in these new-born babies. The reason that the condition discussed by Dr. Herrman has not been more frequently reported is, I believe, because new-born babies have not been studied.

We have had one case within the last six weeks in which we were able to show this process. The mother had an infective condition, a coryza; and the baby had a secondary infection of the throat and otitis media, following these, there was a meningitis, the diplococcus being found in the meninges at autopsy.

I believe, therefore, that such conditions are far more common than has been supposed. In this connection I should like to ask whether there are any other teaching institutions in which material of that character is given sufficient consideration, the proper attention being devoted to new-born infants. There is one such institution abroad, in Vienna, where von Reuss was put in charge of the children in Schauta's clinic in 1911.

DR. KOPLIK: I have seen several cases of meningitis in the new-born. In one child, on the sixth day. This infant was subsequently seen by some of my colleagues. It had pyelitis from infection with the colon bacillus, and subsequently developed a colon meningitis. It recovered from that, and lived until eight months of age. It had an enormous hydrocephalus and died.

The cases we see in the hospital, up to the third month, we call "new-born"; and most of the cases of meningitis in the new-born are streptococcic meningitis. We had one case in a baby of six weeks sent in from the outside, in which the bacteriologic finding was so peculiar as not to be understood. A bacillus similar to the typhoid bacillus was found by lumbar puncture.

The reason that these cases have not been published is that we are waiting to make a collection of such cases before publishing them. Meningitis is not so uncommon in the new-born as is thought; when a new-born baby shows symptoms of meningitis, such as convulsions, the case is usually diagnosed as sepsis, and not meningitis.

DR. LAFÉTRA: I want to emphasize what Dr. Sedgwick and Dr. Koplik have just said. Meningitis in very young infants is more common than the literature would lead us to believe. In a paper that I read before our local society in New York, I reported a number of cases seen at Bellevue. One of the reasons that they have not been reported, aside from the fact that they are not under the care of a pediatrist, is that the symptoms of meningitis, as Dr. Herrman has said, are not evident, the symptoms manifested being those of great depression or sepsis. Cases of sepsis in young babies are not accompanied with high, but with low or normal temperatures. In some cases, they do not run over 99.5 or 100 F. Another symptom commonly presented is marked cyanosis. The fontanel is often not distended. The babies are overwhelmed by the sepsis, and the meningitis is a part of the sepsis.

Various germs are found. Sometimes it is the colon bacillus. We had a case similar to the one that Dr. Koplik mentioned, resembling typhoid. We have been accustomed to make lumbar puncture in cases of cyanosis, on account of the possibility that we have to deal with hemorrhage into the meninges, which is often amenable to treatment. Occasionally we have been surprised to find a meningitis.

DR. HERRMAN: I believe that there are more cases of meningitis in the new-born than I have mentioned. I think that there would be twice as many found if the literature were studied carefully. As Dr. Koplik has pointed out, there are probably many cases that are never reported.

With regard to the control of the new-born by pediatrists, I would say that I discussed this matter at the last meeting of the American Association for the Prevention of Infant Mortality. It would not be possible in all cases to do

that, however. Naturally, some obstetricians do not like to give up what they have, and that makes it difficult in some institutions for the pediatrists to obtain control of the new-born.

With regard to what are called new-born infants, I would state that all the cases that I have mentioned were under 3 weeks. If infants up to the age of 3 months were included, the number of cases of meningitis would, of course, be very much greater.

A CASE OF AMAUROTIC FAMILY IDIOCY IN ONE OF TWINS

CHARLES HERRMAN, M.D.
NEW YORK CITY

J. R., first seen on Dec. 12, 1914, at the age of 20 months. The parents are Hebrews and distantly related. The mother has had kidney and uterine trouble; the father is healthy; one of his brothers is paralyzed. As far as is known no other member of the family has had any mental or nervous disease. The mother is married nineteen years and has been pregnant seven times. First, a miscarriage three months after marriage; second, a boy, now seventeen years of age, attending high school; he had convulsions twice as an infant; third, a girl now fourteen years old, who is in the graduating class at school; the fourth child, which died at the age of one year from pneumonia and convulsions, had been sick for four months; the fifth died suddenly with convulsions; the sixth was a stillbirth; the seventh pregnancy resulted in the twins, of which the patient is one. During the last pregnancy the mother had headache, edema and ascites. The labor was normal; the babies weighed 5 pounds each at birth; they were breast-fed for only two weeks. Both infants developed normally during the first five months; they smiled, held up the head, and grasped objects. After that time the patient paid less attention to his surroundings, was less active, and at eight months he was not able to hold up his head properly, whereas his twin sister could sit up alone. The first teeth appeared at fourteen months (twin twelve months). It was later noticed that the patient no longer grasped or followed objects. Recently he has had convulsions. The patient was admitted to the Lebanon Hospital on Dec. 13, 1914. Examination shows a pale but fairly well nourished infant weighing 18½ pounds (Figs. 1 and 2), apathetic and pays no attention to his surroundings. Cannot sit up or hold up the head properly; does not grasp or follow objects; face expressionless; occasionally a peculiar laugh; starts suddenly at loud noises. Circumference of the head 19¼ inches (18½=normal); four teeth. Examination of the eyes (Dr. Heller): Pupils of moderate size, react sluggishly to light; the examination of the fundus shows an

optic atrophy and the characteristic cherry-red spot at the region of the macula lutea. Examination of the chest shows nothing abnormal. The abdomen is markedly distended; the patient is obstinately constipated. The liver and spleen are not enlarged. The extremities are somewhat spastic, the reflexes increased, the Wassermann and von Pirquet tests negative. After the patient's discharge from the hospital he was frequently examined. The principal symptoms were: Very

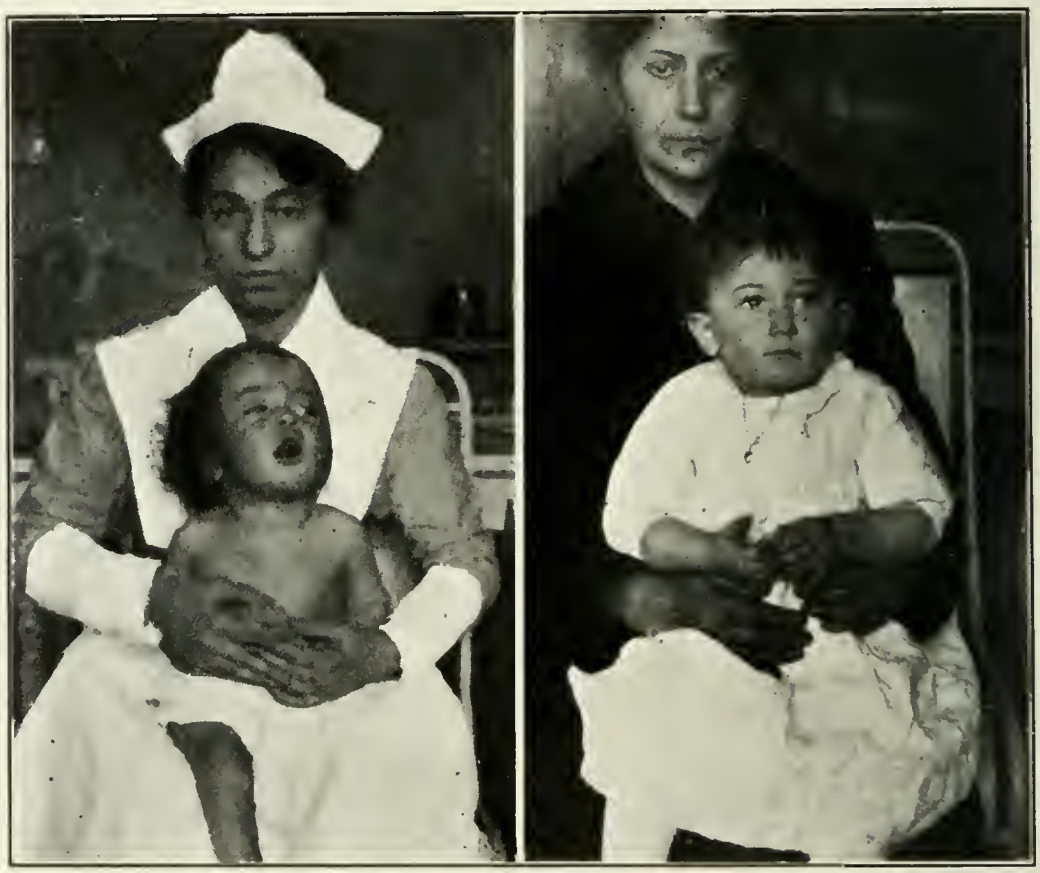

Figure 1 Figure 2

Twins 20 months old. Figure 1, amaurotic family idiocy; Figure 2, normal.

frequent convulsions, often as many as ten a day; obstinate constipation, apparently due to a marked atony of the bowels. The head continued to increase in size, so that on May 3, 1915, it measured 20¼ inches. In addition to the symptoms already noted there was observed fibrillary contractions of the upper eyelids, a peculiar snoring respiration and some difficulty in swallowing.

The pathology, symptomatology and diagnosis of this disease are so well known that I shall only discuss briefly the etiology, upon which

the present case throws some light, at least in a negative way. Alcohol and syphilis have been suggested as possible factors. Aside from the fact that they do not appear in the history of the majority of the cases, it is difficult to understand how a constitutional disease in the mother, or anything which might occur during pregnancy, could affect only one of twins. Some years ago Hirsch held that the changes in the central nervous system were caused by toxic substances which were present in the mother's milk. These infants received the breast only two weeks and it is difficult to understand why it should be toxic for one child only. It is now pretty generally recognized that amaurotic family idiocy is a typical example of an "abiotic" family disease. The "*Aufbrauchstheorie*" of Edinger is practically the same as the "abiotrophy" of Gowers. These infants are born with a central nervous system which lacks vitality; there is a deficiency in stamina or staying power. The structures which are below par ("*minderfertig*") are able to meet the comparatively slight demands of the first few months; later, when these demands become greater, when they should be met by further development, the central nervous system fails to respond and degeneration results.

This explanation is, however, not entirely satisfactory. Sachs and Strauss state the matter thus: "The theory of an arrest of development has to be given up, since embryologists limit this term to the conception of an arrest due to the cessation of the normal morphological growth, whereas, so far as we know, the brain of the amaurotic idiot is morphologically normal at birth and for some time after. . . . The gray matter of the brain and spinal cord is morphologically well formed and, so far as we know, functionally normal up to the age of four or six months. Then there gradually occurs a degeneration of all the ganglion cells and a consequent loss of function. The tendency to this degeneration must be born with the child and must reside in the germ plasm. . . . It is, however, not sufficient merely to predicate an impairment of the germ plasm; this would not explain the normal development of the nervous system through the early months of infancy and its degeneration a few months later. We must suppose that at about the fourth or sixth month some endogenous factor, related to the metabolic processes of the body, intervenes and affects the cells which have inherited a lessened resistance to this agent. The factor may be one which is present in all children, but does not affect

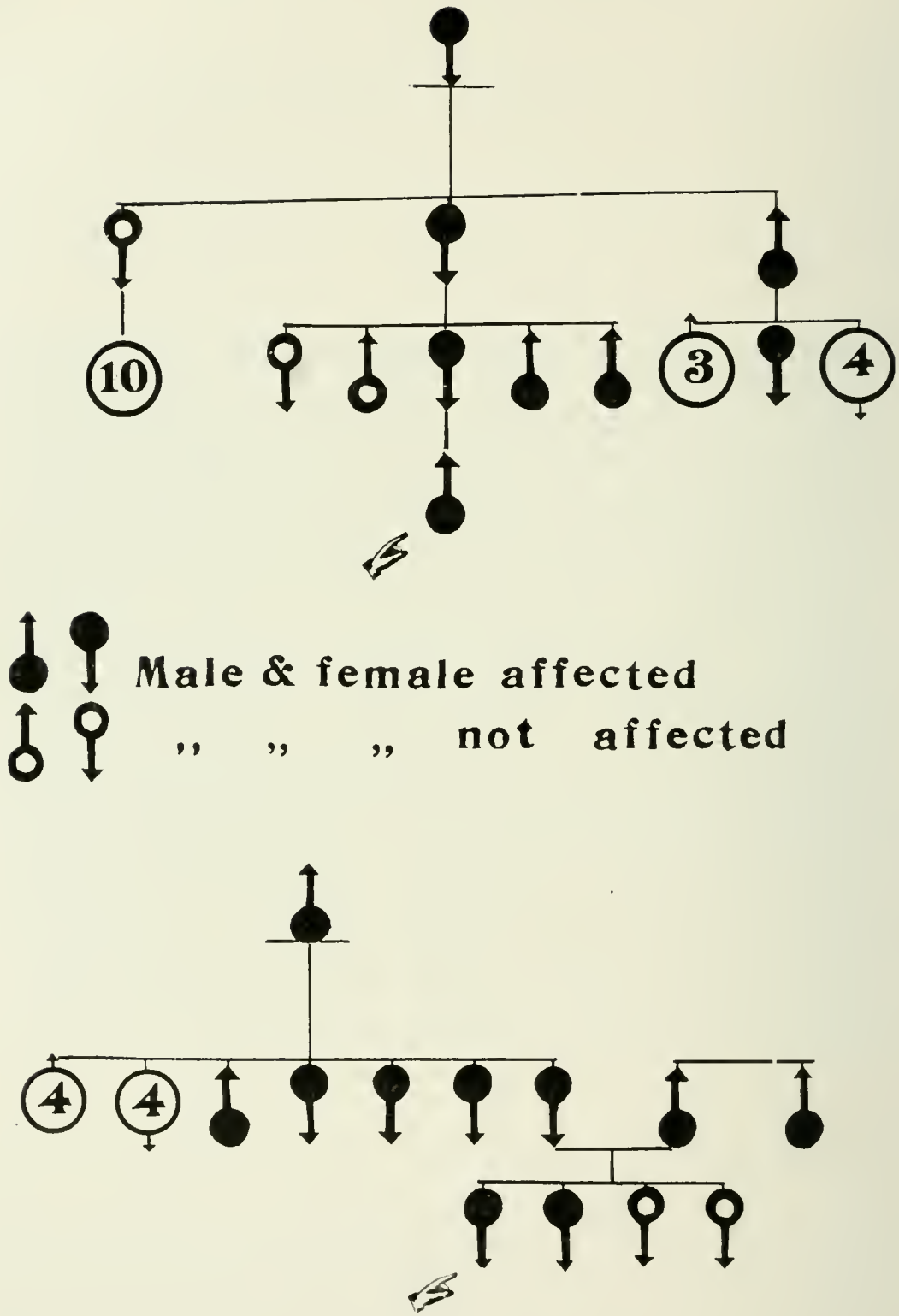

Fig. 3.—Heredity in polydactylism.

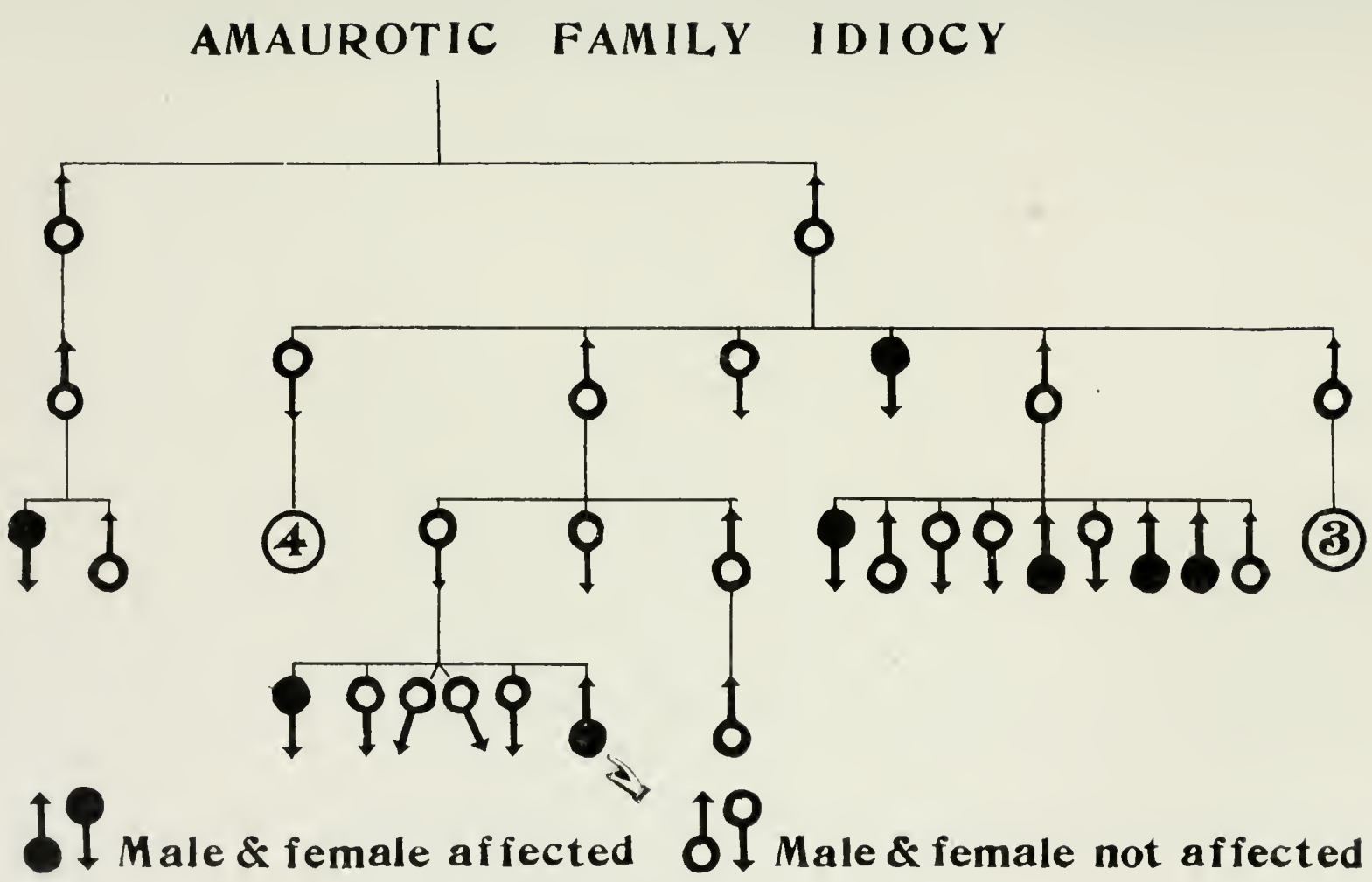

Fig. 4.—Heredity in amaurotic family idiocy.

the nervous system of those who are not born with this inherited weakness." In this connection it is interesting to note that infants under five months are practically immune to measles, a disease to which all other individuals are very susceptible. Possibly at that age some fundamental change (physiological, biochemical) takes place.

About 100 cases of this disease have been reported; many more have not been recognized or reported. On the other hand, the same case is sometimes reported by two observers. I have had 11 cases under observation during the last sixteen years, and I believe it is not at all unlikely that most of these were seen at some time or other by at least one other physician.

It has been frequently stated that the disease is rare in Russia and that it appears in the children of Russian parentage after they have emigrated to this country. This is, I believe, an error; 35 cases have been reported by Russian physicians and two have reported 12 cases each. Kowarski, in the course of two years, observed 6 and obtained the histories of 6 additional. That the condition may be overlooked even by a physician familiar with the disease is shown by the fact that the latter author in two of his patients made the diagnosis of rickets on the *first* examination. The majority of the cases have been reported from the larger cities in which there is a medical faculty attached to the university. Many of the Hebrew emigrants come from the smaller towns of the northwestern part of Russia, where naturally the physicians would be less familiar with this comparatively rare condition. When they emigrate a large number remain in New York City and therefore quite naturally a large number of these patients have been observed and reported by New York physicians familiar with the disease. The larger number of patients among children of Hebrew parentage, the rôle of consanguinity, and the mode of transmission can, I believe, be best understood on the basis of the Mendelian principles of heredity. (Chart 1, Falkenheim's case.) It will be readily seen that even if there were originally two Hebrew ancestors who had the unfortunate unit-character to one Christian the disproportion would become very much greater in the course of a few generations. The fact that the Russian Hebrews frequently intermarry is also important. Consanguinity is important in so far as the parents having two grandparents in common, if there are any unfavorable "unit-characters" in the ancestry, the offspring will get a double dose and will therefore

run a double risk. The "unit-characters" which are involved in amaurotic family idiocy are evidently of the "recessive" type; that is, they may be transmitted through individuals who themselves show no evidence of this disease. In them they are latent or concealed. Chart 2 (showing the families of two cases of polydactylism which I have had under observation recently) represents examples of unit-characters of the "dominant" type; that is, the condition is transmitted only through individuals who are affected.

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DISCUSSION

DR. KOPLIK: It is surprising to see how many of these unfortunate children in the large cities go from clinic to clinic without their parents being informed of the true condition; and I believe that the matter of the incorrect diagnosis is not to be taken too seriously, because physicians hesitate to tell the mothers what the trouble is and state that it is rickets. The ease with which the correct diagnosis can be made should be emphasized. The fact is that when a child that is drowsy, apathetic and limp is brought into the office, the first thing to do is to examine the fundus of the eye. The examination is easily made with the electric opthalmoscope and the diagnosis looks one right in the face.

Regarding the etiology, the German school has pointed out the fact that there is scarcely an individual cell in these children that has not undergone vacuolization and degenerative change. Therefore, the process seems to be a toxic one. Hirsch assures me that he thinks that the disease is congenital, and does not originate after the child is born.

DR. HERRMAN: Regarding the diagnosis, I would state that in the two cases in which the diagnosis of rickets was made, the physician who made it admitted that he had made a mistake. He did not simply say it was rickets, in order not to hurt the mother's feelings and make her unhappy. I think that in many cases the physician might know the cause of the trouble and not tell the mother, but he certainly would tell some other member of the family the seriousness of the child's condition. Therefore, I do not believe that all the mistakes in diagnosis can be explained in that way. I think, however, that very early cases are sometimes difficult to diagnose. The condition of the eyes may not at first be so distinct that the diagnosis can be made readily by means of an examination of the fundus.

Everyone is agreed, I think, that the disease is congenital. We all think that there is something that the child is born with. The difference of opinion is in regard to what takes place at about the fifth month, the child having apparently been normal up to this time, and then showing abnormal symptoms.

As to the opinion of Hirsch, no one differs with him in regard to the disease being congenital, but almost all think that it cannot be due to the breast milk. One of these children was normal, and the other abnormal; and yet they had the same breast milk. That also makes it difficult to explain the disease on the toxic basis. The children were born under the same conditions, and progressed for five months as nearly in the same way as possible. They had the same environment and nourishment, and yet one developed this very severe disease and the other is absolutly normal.

DISSEMINATED MILIARY TUBERCULOSIS—GENERAL—ROENTGENOGRAM OF THE LUNGS AND ILLUSTRATIONS OF SKIN LESIONS

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In the Transactions of the Association of American Physicians, 1913, will be found three similar cases. The report is developed along these lines, viz.:—"Two helps to the diagnosis (tuberculosis)—one of the lungs—the Roentgen-ray; the other of the skin—the eruption." To those cases I now wish to add another. Skin tuberculosis in the very young is sufficiently rare to justify the addition of a single case. Tileston's conclusion that it occurs only in the fatal cases seems to be justified. In other words, it is a terminal event. It occurs when the vitality is seriously reduced.

A Polish child 15 months old entered the Presbyterian Hospital January 11 of the present year and died in the following month, the 24th. The caption of its history tells the story in the shortest terms. Tuberculous meningitis, pulmonary tuberculosis, tuberculosis of the skin (not forgetting to add)—autopsy. There was a history of tuberculosis in the mother and a brother.

The baby, when born, is said to have weighed 9 pounds, to have been breast fed for four months, to have had diarrhea two and a half months and otherwise to have been free of well-pronounced illnesses. Coughs and colds it did have.

Present illness began six months before entrance with wasting. It lost weight till, to quote the broken English expression, "it was skin and bone." Further history is lost in conjecture and the mysteries of a foreign language. Cough — no vomiting — no crying is noted in the record.

Physical examination showed a poorly nourished infant, poorly developed, with little of importance to add save discharging nose and enlarged glands; large gland near one ear, many submaxillary glands, some quite large, many post-cervical, one large in axilla, size of a marble, some small ones in each axilla, large inguinals, no epitrochlears, etc.

Skin eruption, papulo-pustular, umbilicated, over the trunk, most on the back, scanty on the front, a few on the face and on the dorsal surface of the forearm. Some interest attaches to peasized nodules found in the subcutaneous tissue on the left forearm, one on the arm, one in each calf, symmetrically. One of these removed and examined proved to be tuberculous.

The present case is but an echo of the previous published cases. They were of interest mainly as to diagnosis. It was difficult to interpret confidently the physical signs of chest lesions and the Roentgen ray helped to

a diagnosis: the skin lesion was rare and obscure. In the present case the percussion was unchanged, there was no bronchial voice or breathing, no râles in front. At angle of the scapula there were increase of voice and whistling râles. In a feeble marantic infant these would not be conclusive signs. Here is the triumph of the Roentgen-ray picture. The child was pot-bellied, liver and spleen somewhat enlarged, otherwise there is little to record.

Among the negative tests may be mentioned that no tubercle bacilli were found in the sputum, in the feces (one doubtful one is mentioned), and what is more of interest none were found in the skin eruption. They were abundant in former cases.

Skin lesion—microscopic examination (quoting the record):

"Perfectly distinct ulcerated area at one point extending into the tela subcutanea. Epidermis is gone, but there is a small overlying scab composed of fibrous tissue filled with wandering cells and a few polymorphonuclears. The ulcerated areas are composed of a loose reticulated connective tissue

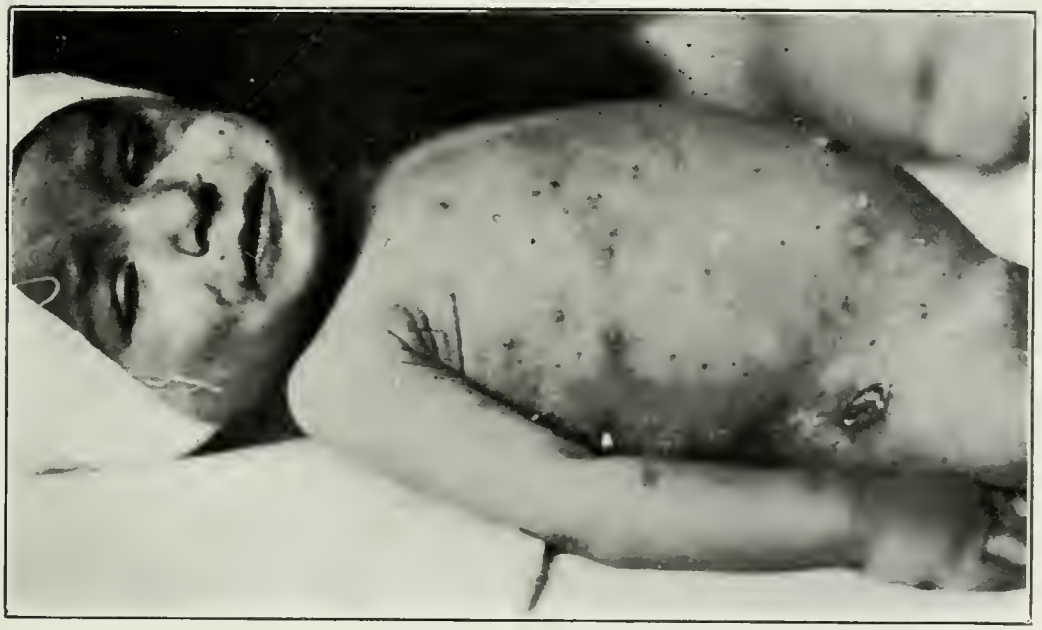

Fig. 1.—Tuberculous eruption in general miliary tuberculosis.

packed with cells. There is a mixture of wandering cells and polys. and some little distance from the ulcer there is a distinct wandering cell infiltration similar to that seen in a section of a positive von Pirquet reaction, but much less extensive. A careful search for tubercle bacilli is fruitless.

"It is impossible to say definitely what the lesion is in the absence of tubercle bacilli, but apparently it is a tuberculid of the skin with some secondary infection." (Dr. Lamb.)

Urine examination, practically normal.

Blood and spinal fluid, practically normal.

Lymph nodes, section showed greater part of node quite caseous. Typical giant cells.

Skin: In the tela subcutanea there is a large, perfectly defined tubercle showing central necrosis but no giant cells.

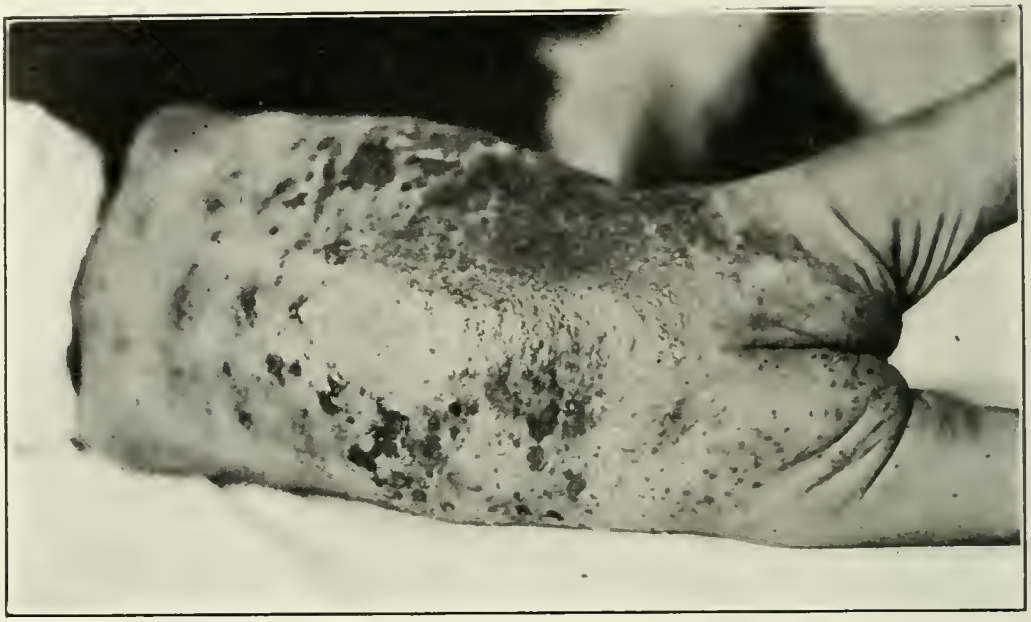

Fig. 2.—Tuberculous eruption of skin—necrotic tuberculid (Pfaundler and Schlossmann.) Macerated skin in middle of back is covered with ointment.

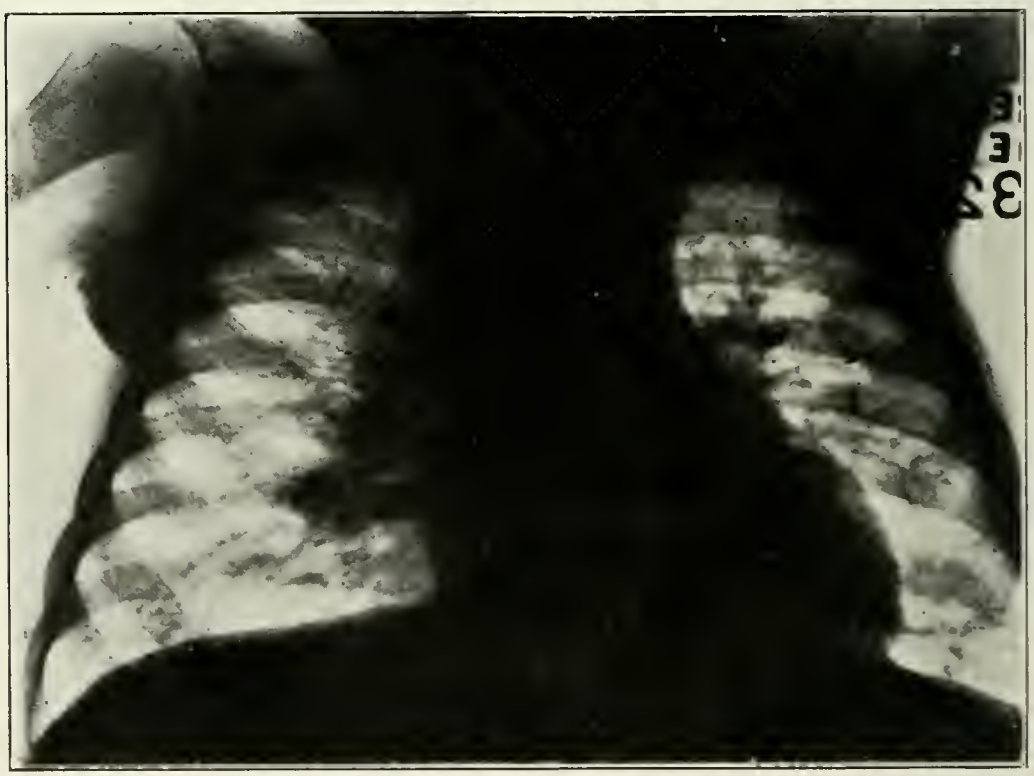

Fig. 3.—Disseminated miliary tuberculosis of the lungs.

Dr. Lamb has no hesitancy in pronouncing tubercle in the lymph nodes and the subcutaneous tissue. The lungs showed widespread scattered miliary tubercles, tubercles in the bronchial glands.

Intestines: tubercle ulcers and mesenteric glands. Colon: large transverse ulcers, large tubercular masses in the meso-colon.

Tubercles in the meninges; edema.

Disseminated tuberculous eruption of the skin, necrotic tuberculid, is not common, that is in infants. Localized tuberculosis is common. Skin specialists have shown me disseminated tubercular lesions of the skin which have little obvious in common with the present. They said they did not expect to find tubercle bacilli in the lesion. My hospital experience leads me to think that the present lesion is rare. Again this case makes one rejoice that the Roentgen ray has come into use and is so successful in infants. One might conjecture and search diligently for bacilli and at the end have no positive proof. The Roentgen ray here serves its most useful purpose. Certainly the physical signs in the chest were not convincing.

This is the fourth case observed at the Presbyterian Hospital. To the best of my memory no case has been recorded from the New York Foundling Hospital. It is sufficiently rare to warrant calling the attention to a single further case. I wish to point to a full description and record of cases by Tileston of Boston in the *Archives of Internal Medicine,* July, 1909, iv, 21. Our own cases may be found in the Transactions of the Association of American Physicians, 1913, under the caption of "Disseminated Miliary Tuberculosis of Lungs and Skin."

MACEWEN'S SIGN

AN ANALYSIS OF THE ANATOMICAL CONDITIONS WHICH ENTER INTO THE PRODUCTION OF THIS SIGN AND OF THE VALUE OF ITS PRESENCE IN DIAGNOSTICATING CHANGES IN INTRACRANIAL PRESSURE

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Percussion of the skull to elicit changes in the note produced by intracranial lesions offers at times valuable additional information as to the existence of disease in the brain and its coverings. That an increase of the spinal fluid does produce marked effect on the percussion note of the skull is a fact which has been noted by various writers during the past thirty-three years.

Macewen first referred to skull percussion in connection with the symptoms and diagnosis of brain abscess. He made use of it for some ten years and found it an aid to diagnosis. He considered the note to be caused by vibrations occurring in the cranial walls and to be influenced by the condition of the cranial contents and their relation to the parietes. Frozen sections made through the heads of hydrocephalic children showed the meninges to be closely crowded against the bony walls. He stated that a thin skull vibrates more readily than a thick one, but that a skull may be so thin or so thick that it cannot vibrate at all. In the cranium of an infant the note is so dull, slight and flat as to be scarcely perceptible. If, however, increased intracranial tension subjects the parietes to pressure, the note becomes clear.

The diagnostic value of the sign has been questioned by some, perhaps largely because as yet there has been no definite attempt made to classify skull percussion with reference to the size, density of the skull, stage of development of the bones, age of the individual, and influence of disease on these bones.

In order to conclude anything from such percussion there must first be established a normal note for the various sorts of skulls that come under observation, as is recognized in the percussion of the chest in the infant or adult with thin or thick walls.

It is such an analysis of the notes produced by percussion of the skulls of children from birth to 12 years of age, children who are

normal as to their osseous development, or those who have suffered in this respect through rickets or other disease resulting in malnutrition, that is the basis of this paper. The observations were made on the service of Dr. L. E. La Fétra at Bellevue Hospital and in the dispensary connected therewith during the years 1911 to 1914.

As percussion of any portion of the body gives us its information by vibration set up both in the parts underlying the area percussed and in the structures making up the body wall at that point, so skull percussion may be expected to vary both with differences in tension in the brain and its coverings and in density of the cranial bones themselves.

Of great influence on this percussion note is the age of the child, determining the thickness and density of the bones, the condition of the sutures, and the size of the fontanel. Different normal percussion notes belong to varying ages with their corresponding states of skull development. Disease influences the character of skull percussion, rickets of course being the best example of this.

Such variations are then physiologic and pathologic in causation; physiologic when depending on the natural changes which occur in the growth and development of the cranial bones, sutures, fontanels and sinuses; pathologic when such changes are accentuated by disease or disturbance in development, and when they accompany abnormal conditions of the brain, meninges or spinal fluid.

Percussion of a hydrocephalic skull or of a skull with wide open fontanels, with open sutures, or marked cranio tabes, will differ from that of the thickened skull attendant on retarded cerebral development. What is true of the cranium itself is equally true of its contents, for as changes in the condition of any viscus under investigation influence the note produced by percussion, so pathologic changes affecting the density or tension of the skull contents will influence its percussion.

Notes produced by such percussion are also affected by position. Percussion of a skull resting on the pillow will be markedly different from the percussion of the same when supported by the hand.

If the variations in the normal skull percussion mentioned are recognized and allowance made for them, then deviation from that normal note may reasonably be considered to be brought about by changes occurring in the cranial contents. Such changes may be those known to be present in the brain and meninges in hydrocephalus in all its forms, in brain tumors, in the acute infections of the meninges,

in some chronic changes which occur from infection in the brain and its coverings and perhaps in the changes attendant on injury such as hemorrhage from fracture.

Crania which have been subjected to the influence of disease and are therefore deficient in density and in the state of fontanels and sutures, present percussion notes varying from the infantile type to a type nearly normal to their age, according to the degree of developmental interference.

A rachitic skull at 6 years will give a percussion note similar to that found normally in an infant of 6 months. If this case develops increased spinal fluid, a sharp high pitched clear note is at once found to have replaced the former dull, low pitched nonresonant percussion.

In congenital hydrocephalus or that occurring so early in infancy that the cranial walls consist in thin fibrous plates with large fontanels and sutures completely open, no note is obtained on percussion. Even when the tension is great there is no structure present suitable to the production of vibrations.

If the disease has developed later in a normally ossified cranium, the note will be most typically "cracked-pot" when the sutures are loose but not widely separated. If the latter are widely separated, the note will be high pitched, sharp and ringing but will have less of the cracked-pot quality.

Our interest in this question began in the admission to the ward of a boy of 7 years for increasing spasticity of the legs and inability to walk, dating from an appendectomy performed three months previously. His history aside from the appendicitis was normal. The mental and physical development had been in no way different from the other children in the family. His teachers reported him to be unusually bright. He had none of the symptoms of hydrocephalus and was not considered as such until attention was drawn to the true condition through the discovery of a striking Macewen. Subsequent findings, confirmed at autopsy, established the diagnosis of early, arrested and quiescent hydrocephalus with exacerbation occurring at the time of his operation.

Less easily proven as accompanying actual intracranial changes are certain variations in skull percussion observed in acute and chronic febrile conditions which do not warrant spinal puncture. Typical Macewen's note is sometimes found in febrile conditions without evidence of cerebral involvement. In the routine examination of a

number of children the sign was found often in children with high temperature due to gastro-intestinal disturbances, in pneumonia, in typhoid fever and in influenza. This does not mean, however, that the sign is any less valuable than some others that accompany and indicate organic lesion, but which may also be produced by transitory and unimportant functional disturbances. For example, the fact that a loud systolic murmur heard over the heart may be produced by slight dilatation of the right or left conus and disappear entirely in a short time, does not detract from the importance that is rightly attached to this murmur, when present, as a result of an organic lesion.

Explaining the occurrence of Macewen's phenomenon in patients free from disease of the central nervous system, is the fact that a temporary increase in volume of spinal fluid under pressure frequently occurs in febrile states not associated with cerebral or meningeal lesion. Macewen's sign has been noted in patients who, on lumbar puncture, show no increase of fluid. In three such instances, however, a large amount of fluid was demonstrated in the brain twice at autopsy and once by puncture of the ventricle, failure to obtain fluid by lumbar puncture being due to occlusion of the foramen leading from the ventricles to the cord. The presence of the sign need not be confusing, therefore, under such conditions.

Macewen's sign is best determined by the stethoscope placed on the forehead just above the base of the nose. The skull is tapped directly, with the percussing finger or hammer over the parietal region, beginning just over the parietal boss from which the percussing finger should approach the point at which the stethoscope is applied. This should be carried out on both sides of the head.

The typical sign observed in this way consists in a high pitched, sharp, short, cracked-pot note. It is most distinct when percussion is being done over, behind or below the parietal boss on either side, is unchanged as the point percussed passes downward, and diminishes in intensity and character as the point percussed approaches the stethoscope. The latter point is important and is valuable in differentiating between a false and true Macewen sign as the reverse obtains in percussing the normal skull. That is, the nearer to the point of listening the tapping is done, the more loudly the note is heard. This is apparently due to the fact that under normal conditions vibrations are better conducted along the bony wall than through the brain and meninges. On the other hand, when there is increased intracranial tension the

skull content plays a more active part in the production of vibrations and the further away from the stethoscope the percussion is done the greater is its influence on the note and the less that of surface conduction. Reason for this belief was repeatedly found in our cases in the observation of the above changes in percussing skulls before and after removal of a considerable amount of spinal fluid.

The percussion note of normal children's skulls varies, as has been stated, with the density of the bones, the size of the fontanels, and the condition of the sutures. In general such variation is comparable to the difference in depth, clearness, and intensity of the tone produced by a drum with intact walls and taut heads and by one whose heads are loosely strung or whose sides are cracked. Each of these above conditions is susceptible to modification, with a corresponding resultant change in the tone. Thus the soft skull with open fontanel and loosely woven sutures gives normally almost no vibratory sound when struck. If such a skull is subjected to increased intracranial pressure, then the percussion note will be changed and although not typical of the sign found in older children, will be relatively striking.

This cracked-pot note of Macewen is to be considered as a relative variation from the normal. Most authors seem to look on it as a definite entity, the contention of Hessman and Feldstein being that Macewen's sign is of no significance in children before the closure of the fontanel. They consider the sign to mean a bulging fontanel *before* its closure, and a cracked-pot percussion note *after* such closure.

After a study of skull percussion in a large number of infants in health and disease, it seems quite practical to establish a note normal to these early stages of development definite enough to make the deviations accompanying intracranial changes of unquestionable value. This has proved true of the infant as well as of the older child.

A child of 7 months was admitted with symptoms of meningitis. The percussion note, normal to a skull of this age, with fontanel measuring 1 inch in diameter, would be low pitched and soft. On percussing this child's skull a typical Macewen note was obtained. The cord was tapped and 30 c.c. of purulent fluid were removed and found to contain the influenza bacillus. After tapping, the percussion note obtained was that, as above described, normal to a skull of this age.

A child of 6 months poorly nourished, with wide open anterior and posterior fontanels and soft sutures, was admitted with retracted head and fever. The percussion of such a skull should normally give a note

even less resonant than that of the first case mentioned. It was found, however, a little high pitched, too loud and too clear for a skull in this condition. The note was characteristic not in its quality so much as in the fact that as the percussing finger moved towards the point at which the stethoscope was applied to the forehead the note became less distinct than when the percussing was done over the parietal boss. This cord was tapped and 35 c.c. of fluid were obtained under great pressure. After tapping the percussion note returned to normal for a skull of this type and the note was louder when tapping was done near the stethoscope than when further away. These two cases illustrate the facts that a typical Macewen note may be obtained in a skull whose fontanels are still open, and that for purposes of diagnosis it is a change in the percussion note expected rather than the presence of the typical note which is of importance.

A group of infants under 6 months of age, and normal as to their central nervous systems, were studied as to skull resonance. The note common to this age is low pitched, nonresonant and dull. Among them were a number with increased spinal fluid and tense fontanels. In one case a typical Macewen's sign was found which disappeared after the removal of 15 c.c. spinal fluid under marked pressure. A case of tuberculous meningitis 6 months of age, had at first a percussion note high enough pitched to be suggestive and later a typical cracked-pot note. An infant of 14 weeks gave a skull percussion definitely abnormal for his age, which was noted as a "dull Macewen" two days before a lumbar puncture was done. Forty-two c.c. of fluid were removed and a diagnosis of tuberculous meningitis was made.

It is apparent that infants may present a typical Macewen's sign. On the other hand, of equal diagnostic value is the difference which may be noted in the infant with increased intracranial pressure and the note common to a normal infant of the same age.

The incidence of this sign in cases of meningeal involvement of all types was observed in relation to the age, condition of skull, amount of spinal fluid, pressure of fluid and other symptoms of cerebral and meningeal disease.

Fifty-three cases of tuberculous meningitis were so analyzed. The sign was present in 50, absent in 2 and doubtful in 1. Of the 50 positive cases, 19 were under great pressure, 18 showed moderate pressure, 6 showed no increase in pressure, and in 7 the point was not

noted. The amount of spinal fluid varied directly with the pressure except in 3 cases, in which 40 to 60 c.c. fluid were obtained under no increased pressure.

Of the 50 cases of tuberculous meningitis showing a positive Macewen's sign, 6 were less than 1 year, 29 were between 1 and 2 years, and 16 were over 2 years. The children having questionable Macewen's sign were 8 months and 11 years old, respectively. The negative case was 6 years old. Macewen's sign was noted in all but 5 instances either before or, at the same time as the development of other cerebral symptoms.

Eighteen cases of acute meningitis of types other than tuberculous were observed, among which there was only one in which Macewen's sign was lacking. This was an epidemic type in a child 2 years old, with little fluid, under no pressure. There were 3 children less than 1 year of age; one between 1 and 2 years; and 12 over 2 years. The pressure was greatly increased in 5 cases; moderate in 10 cases and low in 3 cases. Macewen's sign was noted early in every instance.

Five cases of poliomyelitis all gave positive Macewen's sign with reduction in its intensity after removal of spinal fluid. Two children in this group were 6 months old; the others between 4 and 8 years. Increased pressure obtained in 4 cases, the fluid varying between 15 and 25 c.c. in quantity.

Two children were admitted for chronic otitis with marked symptoms of meningeal irritation. Their spinal fluids showed increased volume and pressure but nothing abnormal on analysis. The Macewen sign was strongly positive at first and persisted so long as the cerebral signs continued. The note became less typical as the mental condition of the patients improved and it was negative on their discharge. In these two instances the evidence obtained from skull percussion tallied exactly with the development of other symptoms and was of value in estimating the necessity for repeated spinal puncture.

Because of marked cerebral symptoms the Macewen test was applied in 13 cases of pneumonia. In 5 of these lumbar puncture was considered justifiable and an increase of normal spinal fluid under pressure was demonstrated. In 8 no puncture was done. Nine children were between 1 and 2 years; 4 were over 2 years. Macewen's sign was positive in 11 cases; questionable in 1 and negative in 1; the latter 2 cases being among those not tapped. These facts are of interest simply in corroboration of the belief that when as a complica-

tion of a nonmeningeal affection the spinal fluid becomes increased, the Macewen's sign is always present, and that conversely, the presence of the sign invariably indicates such intracranial alteration.

CONCLUSIONS

1. The skulls of children of various ages and development have percussion notes peculiar to the state of the cranium.

2. It is possible to establish a note normal to the various types of crania found in infants and children.

3. A positive Macewen's sign exists when variation from the normal note is found. It consists in a relative change rather than a definite condition common to all diseased crania.

4. The sign is better elicited by the stethoscope than by the unaided ear.

5. Increased clearness of sound when percussion is done over the posterior portion of the skull rather than near the stethoscope is diagnostic.

6. The sign uniformly accompanies conditions of increased intracranial tension, and is not found unless this causative factor exists.

7. It is equally applicable to infants and older children.

8. It was present in 50 of 53 cases of tuberculous meningitis.

9. It was present in 17 of 18 cases of meningitis of other types.

10. It was present in all of 5 cases of poliomyelitis.

11. It was found to vary directly with the development and recession of cerebral symptoms as complications of disease not directly affecting the central nervous system.

12. It was present in 11 of 13 cases of pneumonia in 5 of which lumbar puncture showed increased cerebrospinal fluid under pressure.

13. The sign is uniformly lacking in children normal as to the brain and its coverings.

159 East Seventieth Street.

DISCUSSION

DR. LAFÉTRA: I want to congratulate Dr. Wilcox on his persistency in working out this sign, which for many years I have thought to be of practically no value to us. I first became acquainted with Macewen's sign a number of years ago, when I was interested, with one of the attending surgeons at the New York Hospital, in brain cases. When I came to deal with children, it seemed to me that various types of skulls, especially those with open fontanels

and soft bones, made its occurrence valueless. I am glad that Dr. Wilcox has taught me about this sign and shown me that it is of value, although it requires careful attention to the points that he has brought out to make one able to distinguish between a pseudo- and a real Macewen's sign. I did not know about one important feature that Dr. Wilcox emphasizes; and that is that if the stethoscope be placed on the forehead and percussion is done on the side of the head below the parietal bone, the sound in true Macewen's sign will be louder and higher pitched the farther away the stethoscope is from the point of the percussing finger. As one goes forward toward the stethoscope in percussing, the sign becomes less loud and lower in pitch. To me, the pitch is of more value than the loudness. Quite contrary is this to the false Macewen's sign, in which the pitch of the note becomes higher as one approaches the point where the stethoscope is.

I hope that Dr. Wilcox will continue this work, as I think it will be of value in helping us to determine when to draw off spinal fluid in cases that are not meningitis, but meningismus or other type of spinal irritation with increased amounts of spinal fluid.

DR. KOPLIK: My attention was first called to the sign by Dr. Selig of St. Louis when he was an intern and an assistant in my ward. He had been reading Macewen's book, and asked me whether I had met the sign. From then on we began to work it up. I do not find that we can improve on Macewen's old method, to percuss at the junction of the temporal and parietal bones on the under side of the head as it is held to one side. I think that this is the most useful sign that we have in beginning tuberculous meningitis, ordinary meningitis, and serous meningitis due to otitis media. As is the case with every other sign, however, a great deal depends on the skill of the individual who applies it. Some men cannot hear the sound well enough to make any distinction between the sound one gets over the skull in meningitis and that obtained in a normal skull. Such a man naturally thinks that the sign is of no value.

We find the greatest difficulty in applying the sign in the cases of children who have had rickets and, at the age of, say 4 years, have had a little hydrocephalus. Later, when they develop a condition for whose diagnosis we wish to use this sign, it is very difficult to tell how much of the resulting sound is due to the old hydrocephalus, and how much to the new disease. That is the only difficulty that I have found. The older the child, and the more ossified and older the skull, the more valuable is the sign. In very young babies whose fontanels are open, the value of the sign is rather in a palpatory way. If you put your hand on the opposite side of the head and percuss for Macewen's sign, you can feel a wave of fluctuation. In this way the method is exceedingly valuable as a sign of increased fluid in the head.

A PRELIMINARY REPORT ON PNEUMONIA IN CHILDREN WITH SPECIAL REFERENCE TO ITS EPIDEMIOLOGY

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The importance of pneumonia as a cause of death is hardly to be exaggerated. According to the United States census of 1900, pneumonia accounts for 3 per cent. of all diseases, with a mortality rate of 6.6 per cent., or of 12.7 per cent. if only medical cases are considered. It averages not less than 1.5 to 2.3 deaths per thousand persons living. If pneumonia may be called the "old man's friend," it is just as certainly the enemy of youth, and especially of infancy. During early life, the most common seat of organic disease is the lung; and some form of pneumonia is a large—perhaps the largest—factor at the present time in infant mortality. It is probably the only infectious disease in which the etiologic cause supposedly is well understood whose incidence and rate have not been affected by such knowledge.

It is a matter of reproach to the profession that one hundred years of progress and varied methods of prevention and treatment have not affected the mortality rate of pneumonia in either adults or children.

The importance of pneumonia as a disease of infancy is well illustrated from the following mortality table of 1,000 cases, which cover a period of the last nine years in the Babies' wards of the New York Post-Graduate Hospital. The children were all under 6 years of age.

That this mortality rate is not excessive, is shown by a death rate of 33.1 per cent., obtained from a series of 410 cases collected by Holt.[1] Holt's series included 223 cases of bronchopneumonia, and 187 cases of lobar pneumonia in children. The age incidence is apparently about the same in the two series. Pneumonias secondary to infectious diseases, such as whooping-cough, measles, etc., are not included in either group of cases.

Pfaundler has made the observation that children are ill of nutritional disturbances, but that they die of infection. The truth of that

1. Holt, L. E.: Diseases of Infancy and Childhood, Ed. 6, pp. 515-535.

statement is supported by eighty-four of our cases of pneumonia which were frankly secondary to other disturbances, with a mortality rate of 52 per cent. Of these 84 cases, 24 occurred as a complication of malnutrition, rickets and enteritis, with a death rate of 62.5 per cent.

From the clinical standpoint, pneumonia seems naturally to fall into two groups, namely, (1) bronchopneumonia and (2) lobar pneumonia. The differentiation between the two types is important from the standpoint of prognosis, of treatment, and of prevention; and undoubtedly could and should be made more frequently. It is proposed tentatively to prove that the two conditions of bronchopneumonia and lobar pneumonia are not identical either pathologically or bacteriologically.

TABLE 1.—ONE THOUSAND CASES OF PNEUMONIA FROM THE BABIES' WARDS OF THE NEW YORK POST-GRADUATE HOSPITAL

	Cases	Per Cent.
Cured	503	50.3
Dead	343	34.3
Improved	62	6.2
Unimproved	15	1.5
Termination not known	14	1.4
Transferred	63	6.3
Total	1.000	100.0

Bronchopneumonia undoubtedly occurs as a primary condition, but most frequently is secondary to other diseases, such as bronchitis or a moderate or severe intestinal disturbance. A large percentage of the cases in children occur during the first two years of life, though it may occasionally be met with at any age. Of 415 cases treated in the Babies' wards (of the Post-Graduate Hospital) during the first three years of life, 41 per cent. died. In Table 2 it will be noted that the number of cases of bronchopneumonia rapidly diminishes after the second year, so that in this series of 1,000 cases, of which 445 were bronchopneumonia, there are only 31 cases of bronchopneumonia between the ages of 4 and 6 years. In other words, of 445 cases of bronchopneumonia, 414 were infections of the first three years of life; and more than half of all the cases in this group occurred during the first year.

TABLE 2.—BRONCHOPNEUMONIA, SHOWING AGE AND MORTALITY

	Post-Graduate Cases		Holt's Cases	
	Cases	Per Cent. Mortality	Cases	Per Cent. Mortality
During the first year.....	226	52.2	202	66
During the second year....	155	29.0	103	55
During the third year.....	33	24.0	33	33
During the fourth year....	13	0.0	6	16
During the fifth year.....	13	0.0	3	0
During the sixth year.....	5	0.0	...	...

Of the lobar pneumonia cases, there were 227; and they are fairly evenly distributed throughout the first six years, though the first and second years include more than half the total number. It will be noted (Table 3) that the mortality rate is distinctly lower than for bronchopneumonia, being for the entire six years 28.1 per cent. If the first two years of high mortality are eliminated, the death rate falls to 9.8 per cent.

In the following table is seen the *incident of mortality by age in 227 cases of lobar pneumonia* studied in the Babies' wards of the Post-Graduate Hospital.

TABLE 3.—LOBAR PNEUMONIA

	Cases	Per Cent. Mortality
During first year	75	40.2
During second year.....	97	34 0
During third year.....	31	12.8
During fourth year.....	25	16.0
During fifth year.....	21	0.0
During sixth year.....	14	0.7

Judging from this series of 1,000 cases of pneumonia, empyema is not a frequent complication of pneumonia. In all, there were forty-one cases, or 0.41 per cent. of empyema; of which five followed bronchopneumonia, the other thirty-six occurring as a complication of lobar pneumonia.

Pathologically, it is questionable whether empyema ever occurs in a true case of bronchopneumonia. Wollstein and Meltzer,[2] in experimental bronchopneumonia on dogs, by means of intrabronchial insufflation, found practically complete absence of pleurisy in twenty experiments; while in true lobar pneumonia there was always a definite pleurisy, even in nonfatal cases. Consequently, there must be some questioning of the five cases in this series which appear as a complication of bronchopneumonia. A few cases of empyema due to streptococcus have been reported, but the only case which has come directly under our observation was one of *Streptococcus haemolyticus*, occurring as a complication of an undoubted lobar pneumonia due to the pneumococcus.

It should be added that these forty-one cases are not a complete list of all the empyemas which were admitted and treated in the Babies' wards. They include only those cases which complicated a pneumonia *in* the wards. A pneumonia patient is not knowingly discharged from the wards until the temperature has been normal for a number of days and the signs have shown a progressive improvement. The seriousness of empyema as a complication of pneumonia is shown by a mortality rate of 63 per cent.

An interesting and suggestive feature of this series of empyemas is the large number occurring in the year 1913. It will be noted that fourteen cases, or more than half of the total number, occurred during this period. An explanation for this curious phenomenon is rather difficult, but perhaps the one that is the most obvious is a difference in the virulence of the infecting organism. This supposition receives no support from a study of the mortality rate by years. In fact, the mortality rate for the year 1913, as a whole, is somewhat lower than for 1912 or 1914 in the two groups which have been designated as pneumonia and lobar pneumonia. It may be added, however, that the mortality rate during the months of March, April, May, June, and July are decidedly higher than for the corresponding months in other years; while infection occurring during the winter months of this and the previous year seem to have been unusually mild, judging from the number of deaths. Other groups of months may be easily determined to have an unusually high death rate, as, for instance, January and February of this year. The large number of cases which were fatally

2. Wollstein and Meltzer: Jour. Exper. Med., 1912, xvi, 126.

ill during these months, in fact, was the inspiration for the special bacteriological study, the results of which are detailed in this paper.

Opposed to the argument, that pneumonia arises when organisms of increased virulence reach the lung, is the fact that pneumonia rarely occurs in epidemics. A few such epidemics, however, have been described, the most widely advertised of which are those which occurred in Panama during the first year of the American occupation, and the one in South Africa which reached such proportions as seriously to menace the working of the mines. Curschmann[3] describes an epidemic which was supposed to be due to influenza, in which cultures showed in forty-nine cases pneumococci in almost pure culture. The organisms were highly virulent for mice, and presented other characteristics of pneumococci. Leeds[4] describes another such epidemic in which a most careful search for the influenza bacillus was completely negative and the infecting organism was unquestionably the pneumococcus. A careful scrutiny of our cases fails to reveal any evidence of an epidemic, or even of a house infection. In fifty cases very carefully studied from all standpoints during the past four months, there is only one case in which the pneumonia was apparently transmitted from a twin sister—and in this instance the type was that of a bronchopneumonia.

Cole,[5] following the method of Lamar and Meltzer, of bronchial insufflation with broth cultures of various strains of pneumococci, has been able to prove that in rabbits, at least, the production of lobar pneumonia is somewhat dependent on the race of organisms used. A pneumococcus having very slight virulence may end in recovery of the animal without lung lesions, while if the organism is too virulent the animal quickly succumbs to a septicemia, and at necropsy shows only congestion and edema of the lungs. Lamar and Meltzer[6] were the first to regularly produce a lobar pneumonia in animals, though Wadsworth,[7] eight years earlier, by carefully balancing the general resistance of the animal with the virulence of the race of pneumococci employed, and by injecting the organism intratracheally, produced in

3. Curschmann: München. med. Wchnschr., 1909, lvi, 377.
4. Leeds: Ztschr. f. Hyg. u. Infectionskr., 1912, lxxi, Part 3.
5. Cole: Arch. Int. Med., 1914, xiv.
6. Lamar and Meltzer: Jour. Exper. Med., 1912, xv, 133.
7. Wadsworth: Am. Jour. Med. Sc., 1904, cxxvii, 851.

a series of rabbits a diffuse exudative inflammation like the acute lobar pneumonia seen in man.

Wollstein and Meltzer by the use of other organisms, such as streptococcus and influenza, produced on all occasions a diffuse lesion which resembled closely that seen in bronchopneumonia.

An important factor in the production of pneumonia in animals is the number of organisms used. Even in susceptible animals a considerable number of virulent organisms is necessary to produce an infection. Gillespie[8] carried on some important experiments which have a bearing on this problem of why, when a considerable number of virulent organisms is injected, there is multiplication and infection; while if only a few organisms are injected they fail to multiply. It has long been recognized that in starting a culture of pneumococci in broth, the number of organisms used depends on the amount of culture medium. For instance, an ordinary loopful of pneumococci might be sufficient to start a growth in 10 c.c. of bouillon, and result in failure if a liter of bouillon was used. Even on serum-agar the growth is more rapid and profuse if a stab into the culture is made and the smear started from this point. If the culture is made in a solid medium, one organism probably produces a colony. Gillespie was able to show that if the inoculation was made on filter paper kept constantly wet by bouillon, a growth would occur with an inoculation of as small a number of organisms as is required in agar, and with a much smaller number than is required to inoculate the bouillon. The conclusion was drawn that for growth to occur the pneumococcus must change the medium immediately surrounding it, and that where diffusion is great the local changes cannot be kept sufficiently constant unless there is a considerable number of organisms in close proximity. This observation has an important bearing on the production of pneumonia. It is not considered that in order to produce pneumonia any such number of pneumococci must be introduced into the infantile being as was necessary to cause a pneumonia in the animals experimented on by Lamar and Meltzer, but it does appear to be reasonable to suppose that if by any process a few of the terminal bronchioles are occluded, forming a small closed cavity, that pneumococci would be in a situation favorable for their multiplication. According to Cole,[9] extension of the process apparently takes place, in adults, at

8. Gillespie: Jour. Exper. Med., 1913, xviii, 584.
9. Cole: Arch. of Int. Med., 1914, xiv, 8.

least, from one lobe to another through the bronchi, as the study of large sections through lobes with beginning involvement shows. It is common knowledge that pneumonia in children, in a large number of instances, follows after a few days of coryza, cough, and not infrequently a bronchitis. It may well be that conditions of this nature, extending along the bronchi, produce a favorable environment for the growth of pneumococci, which, as may be seen from Table 4, are so frequently present in the upper respiratory tract of children.

The table shows briefly the results of plate culture of sputum in blood-agar. Where necessary, the pneumococcus findings were verified by inoculation into mice, but as a rule, the color of the colony, the morphology, and the action of bile on the organism served to identify it. The specimen was nearly always taken from the upper part of the larynx with a bent applicator. In addition to this series, in which the lung, with one or two exceptions, was free of any known lesion, smears were made from twenty-three cases of lobar pneumonia in which the sputum was virulent for mice. In all of these, a gram-positive diplococcus was found, and in nearly every case it was the predominating organism, with a few scattered streptococci and staphylococci. In ten cases of mild bronchopneumonia, the sputum of which did seem to be virulent for mice, the predominating organism was in five cases streptococcus; two cases each of staphyloccus and influenza; and in one case, tubercle bacilli with other organisms.

There were eight cases of bronchopneumonia in which the sputum was virulent for mice, and in all of these a large number of pneumococci were found in the smears. There were in addition, however, many other organisms, chiefly of the streptococcus and staphylococcus groups, so that these infections could fairly be labeled as mixed infections. These findings would explain in a measure the difference between a bronchopneumonia and a lobar pneumonia—the bronchopneumonia being a mixed infection, or an infection chiefly with a single type of organism other than the pneumococcus. For this reason, the inflammation is peribronchial in character and consists primarily of an infiltration of interstitial tissue with leukocytes. The exudate into the alveoli is moderate and contains little or no fibrin. In lobar pneumonia, the inflammation is due chiefly or entirely to the pneumococcus and is not peribronchial in character, and the framework of the lung is free of infiltration. The exudate is considerable and contains a large amount of fibrin. According to Wollstein and

Meltzer, slightly or nonvirulent pneumococci produce an exudate that resembles that of a virulent streptococcus in the small amount of fibrin present in the exudate.

The question naturally arises as to why infection occurs at all. It has just been shown that pneumococci were found by cultural methods

TABLE 4.—ORGANISMS IN UPPER RESPIRATORY TRACT

	Age	Pneumo-coccus	Strepto-coccus (Hemo-lytic)	Strepto-coccus Viridans	Staphylo-coccus
Regulation of diet	4 mos.	....	+ +	...	+
Regulation of diet	2 mos.	±	+ +	....	+
Regulation of diet	14 w'ks	+	....	+	+
Regulation of diet	16 mos.	....	+ +	....	+ + +
Regulation of diet	7 w'ks	....	....	....	+ + +
Regulation of diet	.....	±	....	....	+ +
Regulation of diet	1 mo.	....	....	....	+ + +
Regulation of diet	.....	....	+	+ + +	+
Regulation of diet	4 mos.	....	....	....	+ +
Regulation of diet	10 w'ks	....	+ +	....	+ +
Regulation of diet	4½ mos.	±	....	....	+ +
Regulation of diet	5 w'ks	±	+ +	.. .	+
Malnutrition	3 mos.	....	+ +	....	+
Tertian malaria	12 mos.	....	+ +	....	+
Hypertrophied tonsils — anemia	31 mos.	....	+	....	+ +
Acute intestinal toxemia	2½ years	....	+	....	+ +
Tuberculous peritonitis	24 mos.	+	+ + +	....	+
Chronic endocarditis	5 years	+	+ + +	....	....
Regulation of diet	12 mos.	....	+ + +	...	....
Empyema	3½ years	+	+ + +	+	....
Pneumonia	4¾ years	+ +	+	....	....
Rickets	1¼ years	....	+	....	+
Otitis media — rickets	22 mos.	+	+ +	....	+
Pyelonephritis	24 mos.	....	....	+ +	....
Hospitalism	4 mos.	+ +	+	....	+
Eczema	15½ mos.	....	+ +	....	+
Von Jacksch's pseudo-leukemia	3 years	+	+	+ +	....

in approximately 25 per cent. of the throats of small children examined in a routine manner in our wards (lungs free). There is no evidence to show that the organisms normally in the throat differ from those which cause pneumonia. There is considerable evidence that different races of pneumococci vary in their virulence toward

animals. But the fact remains that some of these organisms which have little virulence for animals have been recovered in cases of severe pneumonia. Whether the resistance to pneumococci has temporarily been lowered in these patients sick with pneumonia, is a speculative question to which no reply has apparently been made. It may be believed that the infection is the result of combination of circumstances, such as the natural or acquired resistance of the individual, the state of the vitality of the individual, local changes in the respiratory tract which precede the infection, and, finally, the virulence of the organism.

Dochez and Gillespie,[10] in their important study, have been able to show that the pneumococcus is a family which by the extraordinarily specific methods developed from the study of immunity can be subdivided into many races having varying degrees of virulence. They liken their subdivision of the family of pneumococcus to other grosser methods of classification, such as differences in growth or cultural characteristics that are sufficient in certain groups of organisms for differentiation. From the etiologic standpoint, they do not consider these fine lines of division as important, but from that of specific therapy these differences are of primary importance. At the Rockefeller Institute, under the direction of Dr. Cole,[11] they began in 1910 to use an immune serum that was prepared by injecting a horse with a culture of pneumococcus obtained from Professor Neufeld, the same race he had used in the production of his immunized serum. The protective power of this serum for mice was found by Dochez[12] to be effective in only about one-half the cases. A biologic classification of pneumococci was then undertaken by Dochez and Gillespie.[13] Rabbits were immunized to each race of pneumococci, and the protection afforded by these different rabbit serums against all other races of pneumococci was determined.

A considerable number were found to show cross-protection, that is, a serum prepared by injections of one of the number acted on

10. Dochez and Gillespie: Jour. Am. Med. Assn., 1913, lxi, 723.

11. Cole: Arch. Int. Med., 1914, xiv, 29.

12. Dochez: Jour. Exper. Med., 1912, xvi, 680.

13. Dochez and Gillespie: A Biological Classification of Pneumococci by Means of Immunity Reactions, Jour. Am. Med. Assn., 1913, lxi, 727.

all the races of this group. A horse was then immunized to one of this group and the serum was called Serum 2. In this way, the pneumococci obtained from all cases of pneumonia were separated into four groups.

Group I contains all those races against which Serum 1 is effective.

Group II contains all those races against which Serum 2 is effective.

Group III consists of all the organisms of the so-called *Pneumococcus mucosus* type. The individual organisms show a voluminous capsule containing medium sized closely approximated cocci with definitely rounded ends. They produce a sticky exudate in animals, and on solid mediums a moist transparent mass.

Group IV includes all the cases against which Serum 1 and Serum 2 are not effective and which from their other properties do not belong in Group III. This group seems to consist of entirely isolated individuals, the significance of which it is difficult to interpret according to Dochez. It may be that this heterogeneous group may be representative of the type of pneumococcus found in the normal mouth.

In our experiments there were obtained by culture eleven strains of pneumococci from the throats of children having no lung involvement. In one case, pneumococci of Group I were obtained before physical examination revealed a lobar pneumonia.

The chief difficulty met with in babies and small children was the obtaining of a sufficient specimen for a direct mouse infection. The method which was finally adopted was a simple one, consisting of tongue depressor, placed well back on the tongue and down in the throat. This method resulted in some gagging and more or less coughing, which in most cases brought a plug of mucus up into the throat, which was caught on the spatula. While the amount obtained was often scanty, only occasionally was it necessary to take a second or a third specimen. The method used from this point closely follows Dr. Cole's description of the method used at the Rockefeller Institute. The sputum was immediately injected into the peritoneal cavity of the mouse. The peritoneal cavity was washed with salt solution as

soon as the mouse showed symptoms of being severely ill. The cells were thrown down in a centrifuge, a suspension of the organisms being thus obtained. The agglutination test was at once made with Serums I and II.

At the same time that this was being done, a very small amount of blood was withdrawn from the heart and smeared across a blood-agar plate. In twenty-four hours the type of colony could be studied on the plates and further agglutination or cultural tests made. The work was checked by a gram and capsule stain (His's method), and by lysis of the bacteria with bile. In making the agglutination tests from the peritoneal washings, the amount used depended somewhat on the opacity of solution containing the suspension, and 0.3 c.c. of the serum was the amount employed.

Our final test was always made with an eighteen-hour old broth culture inoculated from typical plate colonies. Equal amounts of the broth and serum were employed in the test (as a rule, 0.3 c.c. broth culture and 0.3 c.c. of serum). It was noted that a fairly high dilution of the serum often made it difficult to obtain an agglutination, but as a matter of fact, the organisms seem to have the property of remaining suspended in the serum used, even though the serum was not diluted at all. Readings were made macroscopically at the end of one and two hours at 37 C., and again after standing twenty-four hours in the ice-box. Usually, agglutination was visible in fifteen minutes, or half an hour, and consisted at first of a fine granulation followed by a sinking of clumps which formed a thin layer on the bottom of the tube that could not be broken up even by vigorous shaking.

The serum of Groups I and II was obtained through the kindness of Dr. Cole at the Rockefeller Institute. Somewhat to our surprise, for we expected many of our pneumonias to fall into Group IV, our cases paralleled quite closely those at the Rockefeller Institute so far as groups are concerned. We obtained many more in Group II than Dr. Cole's published results would seem to warrant, but in a personal communication Dochez has told us that they, too, had an unusually large number of organisms fall into Group II during the past winter. The following table briefly summarizes our positive results:

TABLE 5.—Summary of Positive Results*

	Number of Cases of Lobar Pneumonia	Number of Cases of Broncho-Pneumonia	Primary	Second-ary	Deaths	Cures	Total Number of Cases	Per Cent. Mortality
Group I....	9	2	9	2	1	10	11	9
Group II...	11	43	12	2	5	9	14	36
Group III..	1	3	2	2	1	3	4	25
Group IV...	7	12	6	11	4	15	19	21

*In addition to the 48 cases described in Table 5, there were 23 cases in which no pneumococci were found. Of these 23 cases, 12 were bronchopneumonia and 3 were of the lobar type in which practically all local symptoms had disappeared. In the cases of bronchopneumonia failure in some instances may have been due to the small amount of material obtained, but it is only fair to add that smear preparations were in the majority of instances also negative for pneumococci. Eight control cases, showing no respiratory symptoms of any kind, were studied by smears and injecting of sputum in the peritoneum of mice with negative results. In all a total of 71 cases were studied.

It will be noted that there are forty-eight cases in which it has been possible to determine the group to which the pneumococcus causing the infection belongs. Of the twenty-three cases in which it was not possible, for one reason or another, to obtain a pneumococcus culture, in at least three a positive result would in all probability have been obtained with a proper specimen. Empyema occurred as a complication in seven of these cases. With one exception, the organism recovered from these empyemas was the pneumococcus, of which two belonged in Group I, three in Group II, and one in Group IV. The seventh case gave a pure culture of *Streptococcus haemolyticus*.

Our mortality rate for the groups, with the exception of Group IV, is somewhat lower than in the series published by Cole (Table 6). For purposes of comparison, mortality percentages for the two series are placed side by side.

TABLE 6.—MORTALITY RATE FOR THE GROUPS IN AUTHORS' AND COLE'S SERIES

	Authors' Series Per Cent.	Cole's Series Per Cent.
Group I	9	24
Group II	36	61
Group III	25	60
Group IV	21	7

The number of cases in both series is as yet insufficient for the determination of the absolute mortality rate in each group. As our series is based on children under 6 years of age, a comparison with Cole's adult cases is obviously unfair. Lobar pneumonia decidedly predominated in Groups I and II, while rather more than half the cases in our Group IV were clinically bronchopneumonia; while the cases dealt with by Dr. Cole are exclusively of the lobar type. Moreover, there is an actual difference in the mortality rate in the two series, ours being 23 per cent., as opposed to Dr. Cole's 38 per cent. In all probability this marks another difference in the two series, as we used every pneumonia case that came into our general service, while probably only very ill patients were sent to Cole's[14] service at the Rockefeller Institute.

14. Cole: Arch. Int. Med., 1914, xiv, 33.

SUMMARY

From a study of a thousand cases we have established a mortality rate for pneumonia in children of 34.3 per cent. It is admitted that this is probably a higher rate than obtains in private practice among well-to-do people, but is the average for the mass of city dwellers.

Bronchopneumonia is pre-eminently a disease of the first two years of life, and after the third year is relatively uncommon. Lobar pneumonia is the type of the disease which is present after the third year in practically all cases of pneumonia, if those cases which are frankly secondary to some other condition—such as one of the infectious diseases or where the pneumonia occurs as a terminal infection—are omitted.

Lobar pneumonia per se is a common condition in the first and second years of life, being much more frequent than is commonly supposed.

The infection which is the etiologic factor of lobar pneumonia is always the pneumococcus, while a bronchopneumonia may be due to a number of organisms, such as the streptococcus or the influenza bacillus, occurring alone or as a mixed infection. If pneumococci are present in bronchopneumonia, they are usually one of a group of organisms, or at least are of a low virulence and resemble the organisms commonly found in the mouth.

The pneumococcus may be divided into four general groups, each being made up of many races which are closely related. By the method outlined, a pure culture of pneumococcus may be obtained and the group determination completed in about twenty-four hours from any given case of pneumonia. The division of the pneumococcus into groups is of the greatest importance from the standpoint of treatment. Obviously, the treatment of a lobar pneumonia due to a pneumococcus of Group II with a serum or vaccine prepared from an organism of Group I is a waste of energy and might be positively harmful in its effect.

Pneumonia is the most common, is the most fatal, and is the least studied disease that occurs among children. Any work which brings new facts relating to its treatment or new possibilities of improved methods and prevention is worthy of the careful consideration of all those who are interested in the welfare of children.

It is hoped that the division of pneumonia into groups will eventually bring about treatment by specific serums or vaccines, replacing the symptomatic treatment of today.

DISCUSSION

DR. GRAHAM: If I understood Dr. Pisek's figures correctly, he said that 41 per cent. of his cases of lobar pneumonia developed empyema. It has been my experience that the percentage of empyemas that one meets with in pneumonia varies very much from year to year. You may go for several years and see only a few cases; and perhaps during the following year a large proportion of the cases will develop empyema.

With regard to the mortality of empyema cases, if I caught the figures correctly, Dr. Pisek said that the mortality in these cases was 63 per cent. That certainly differs very radically from my experience of empyema in lobar pneumonia. I think that it makes a great deal of difference whether you take the cases from hospital or from private practice. Personally, I have always considered that the child in private practice who had an empyema following lobar pneumonia would, in the large majority of cases, recover. In hospital practice, I am quite sure that I have a very much larger percentage of recoveries than 63. I have not kept an accurate record, but I feel convinced that in hospital practice, whether it is in a child under 5 years of age, in whose case we commonly do not resect the rib, or in one over that age, in whose case it is the common practice of physicians to resect the rib, our mortality is nothing like 63 per cent. Whether this is merely our experience or the common experience of pediatrists, it is yours to decide.

DR. SEDGWICK: There is one point that Dr. Pisek mentioned that should be emphasized concerning our part of the country. The mortality is quite different in Minneapolis in this regard. This fact was impressed on my mind particularly in adult practice. I went from my internship in a large hospital in Chicago, where the pneumonia mortality was high, to practice in Northern Minnesota, and found that Dr. Barrett had a record of 125 cases of lobar pneumonia, among adults, without a single death. I was skeptical about this death rate at first, but later learned from my own experience that he was correct. I had thirty-five cases in adults, with a mortality of one, a very old man. At Minneapolis, in hospital, as well as in private practice, the mortality of lobar pneumonia in infants and young children is very low. I think that there is a difference in the results at different places, as Dr. Graham says. The mortality rate given by Dr. Pease represents large city records. In smaller cities the conditions are not the same. In Minneapolis, the mortality is much lower. Whether this is due to good housing or what, I do not know.

DR. BLACKADER: A high mortality in lobar pneumonia does not represent the experience that we have in Montreal.

DR. PISEK: What Dr. Graham says would be borne out by the fact that a great number of our patients are young children. In an institution of this sort, it is the critical cases that are sent in. The children that are doing well in private practice are kept at home. We often get the cases on the sixth or seventh day, because they are doing badly. If we were to analyze our cases by age, we should find that the empyema cases occur from the first to the

eighteenth month. A great deal depends on the judgment and activity of the surgeon. If he is conservative, the young children have a better chance to live than when he is less conservative.

I believe that what I have to say will answer Dr. Sedgwick's criticism. In outlying districts and where the children are in better circumstances, they stand the pneumonia better. These statistics, however, are the facts, and we stand by them. These are children that come into the hospital from city practice; and if mortality statistics were taken elsewhere, under similar urban conditions, I think it would be found that these are not very far off from the average.

A CASE OF CONGENITAL HEART DISEASE WITH DEMONSTRATION OF SPECIMEN

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Eli S. was born at full term, after a normal delivery, about Jan. 1, 1906. He weighed 3 pounds. His mother noticed, when he was 4 months old, that his lips, cheeks and nails were always blue and that at times he was blue all over. He was feeble from the beginning and, when he was old enough to exert himself, showed dyspnea on exertion. He had scarlet fever when he was 2 and whooping-cough when he was 3 years old. He was brought to the Children's Hospital for the first time Dec. 1, 1909, when he was about 4 years old. At that time he was small, but well nourished. His lips and nails were very blue and the mucous membrane of the mouth was cyanotic. There was marked, general cyanosis when he cried. There was marked clubbing of the fingers and toes and some bulging of the precordia. The heart was somewhat enlarged in both directions, and a very faint murmur was heard at the junction of the sternum and the third and fourth ribs on the left. There was also a very slight systolic murmur in the pulmonic area. These observations were made by a house officer, however, so that there is some question as to their accuracy. The patient was seen and examined repeatedly by various members of the visiting staff from that time until his final illness and no murmurs were ever heard by any of them. He developed well, was active and showed no evidences of discomfort referable to his heart. He was generally cyanotic, and the clubbing of the fingers and toes became extreme. The conjunctivae were discolored. There was no enlargement of the liver or spleen.

The blood showed from 120 per cent. to 140 per cent. of hemoglobin by the Sahli apparatus. The red corpuscles varied between 7,800,000 and 13,675,000, most of the time being between 11,000,000 and 12,000,000. The white count varied between 8,000 and 12,000. The differential count of the white cells showed on the average 32 per cent. of mononuclears and 68 per cent. of polynuclear neutrophils. There were never any abnormalities in the red cells.

The urine was normal at repeated examinations.

Aug. 9, 1914, when a little more than 8½ years old, the patient had an acute attack in which he vomited blood and passed blood in the stools. He was brought into the hospital in collapse, but had no recurrence of the hemorrhages. The urine contained albumin, casts, and a little microscopic blood. It was clear in about a month. The heart at that time measured 4 by 9.5 cm. There were no murmurs. The liver was 1 cm. below the costal border. The spleen was not palpable. The blood showed a white count of 33,800 at that time.

Subjective symptoms developed for the first time in early November, 1914. The patient was able to walk, but any greater exertion caused cardiac distress. He was unable to attend school or play. He complained of pain in the right

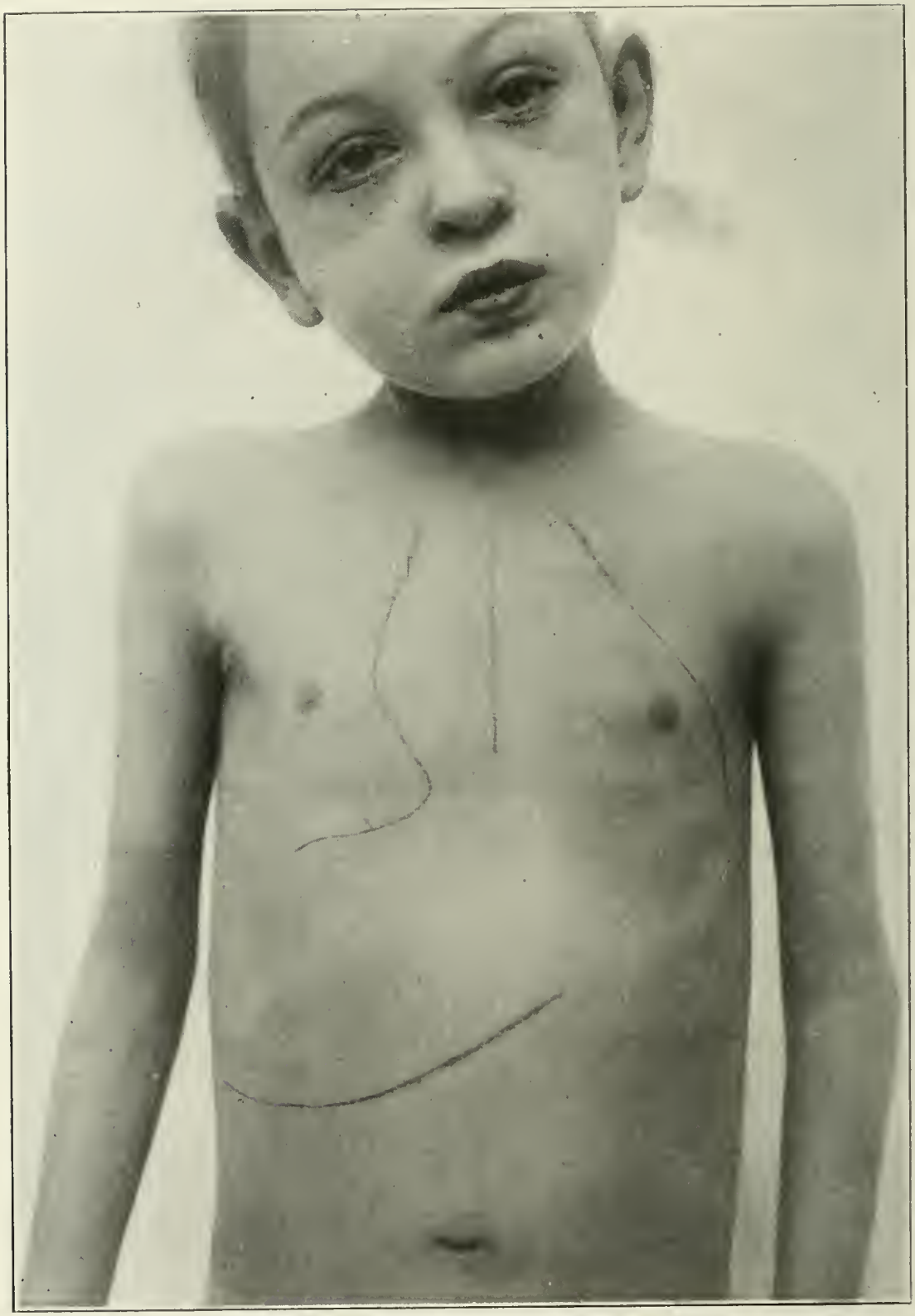

Fig. 1.—Patient with congenital heart lesion.

chest. The cardiac measurements were 4 by 9 cm. There were no murmurs. The liver was 1 cm. below the costal border. The spleen was not palpable. He was examined at this time by Dr. L. E. Holt, who also heard no murmur.

The patient stayed in the hospital only a few days at this time, but returned Nov. 30, 1914, with the story that he had been perfectly well until the night before, when he began to have constant and severe pain in the abdomen, with high fever and vomiting. The cyanosis was greater at this time than ever before and the temperature was 103 F. The condition of the heart was the

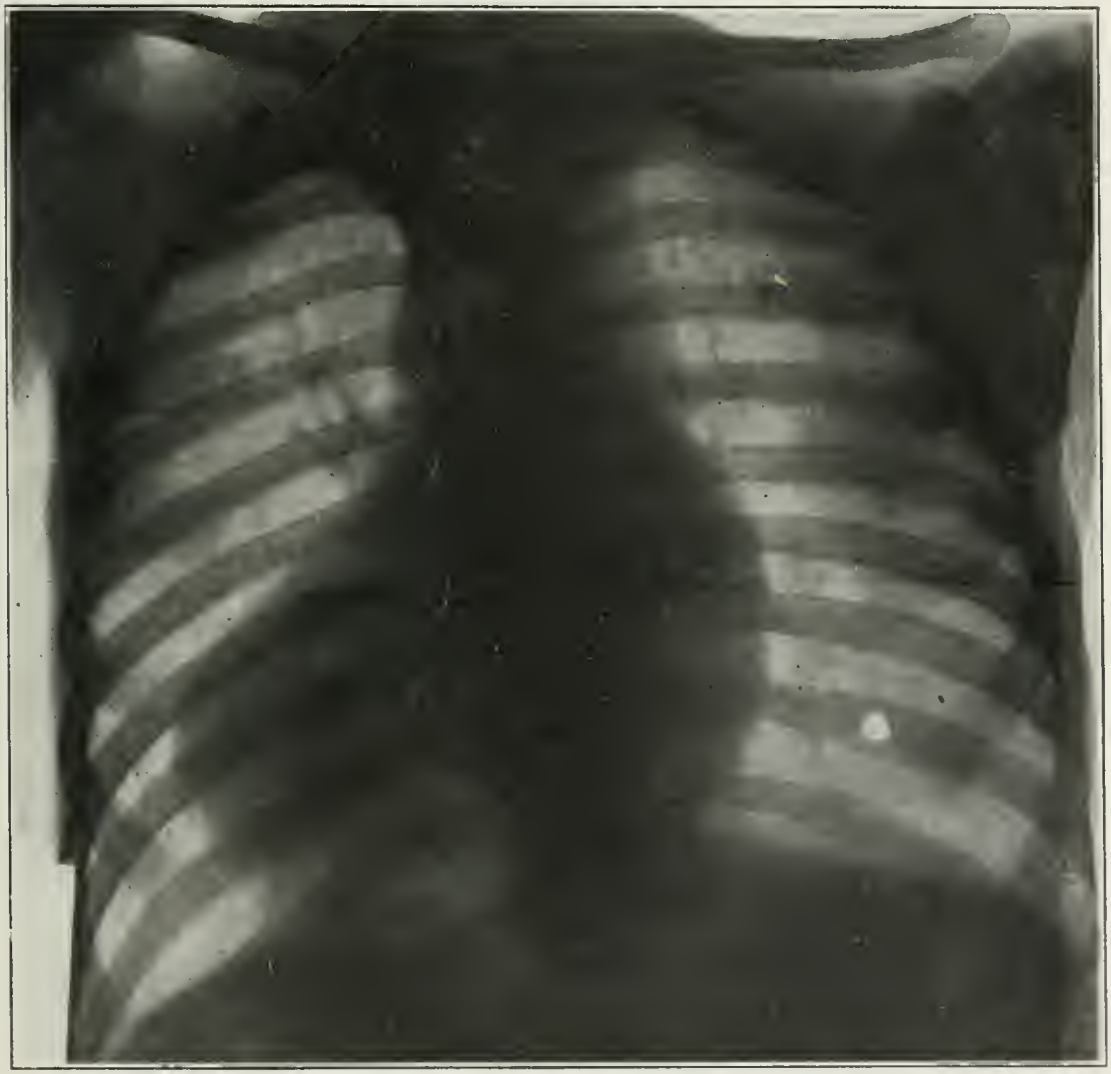

Fig. 2.—Heart as shown by Roentgen ray.

same, except that it extended 10 cm. to the left. The urine was full of normal blood and also contained bile. The patient became slightly jaundiced during the next few days. He quickly improved, however, so that on December 4 the urine was normal. He was examined carefully December 2 by myself and several other men, including Dr. H. A. Christian. There were no murmurs in the heart and there was no palpable thrill. The temperature had in the meantime dropped to normal in the morning, with an evening rise to 100 or 101 F.

He was not examined December 3. December 4, a diastolic murmur was present over the whole precordia, loudest in the pulmonic area.

The examination of the heart, Dec. 7, 1914, was as follows: The right border of the heart was 4.5 cm. to the right of the median line, and the left border 11 cm. to the left of the median line. The upper border was at the lower border of the second rib. The action was regular. There was a high-

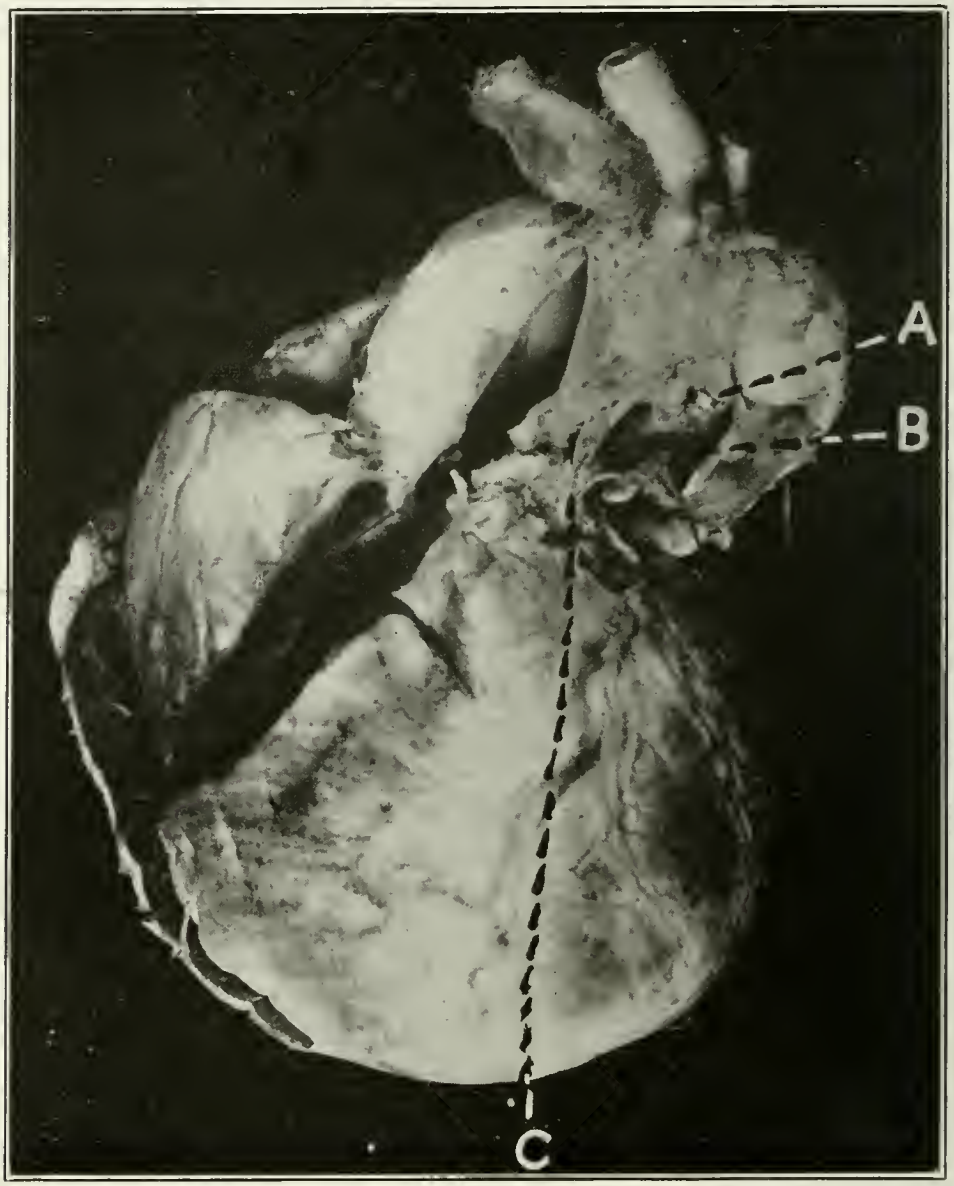

Fig. 3.—View of heart showing *A*, ductus arteriosus, *B*, two vessels to lungs, and *C*, rudimentary pulmonary artery.

pitched murmur beginning just before the first sound, accompanying the first sound and continuing a little after it. The second sound was accompanied by a long, somewhat rough murmur, which was loudest in the third left space. It was louder in the pulmonic area than in the aortic area or at the apex. The second sound was distinct. Figures 1 and 2 show the conditions at that time.

The measurements of the heart on the roentgenogram (Fig. 2) are as follows: Right border: first space 3 cm.; second space 4 cm.; third space 4.5 cm.; fourth space 2.5 cm. Left border: first space 3.5 cm.; second space 7 cm.; third space 11 cm.; fourth space 11.75 cm.

At this time the cyanosis was somewhat less than it had been in the past. There was no edema or ascites. The liver was palpable 3.5 cm. below the costal border in the nipple line. The spleen was not palpable. The hemoglobin came

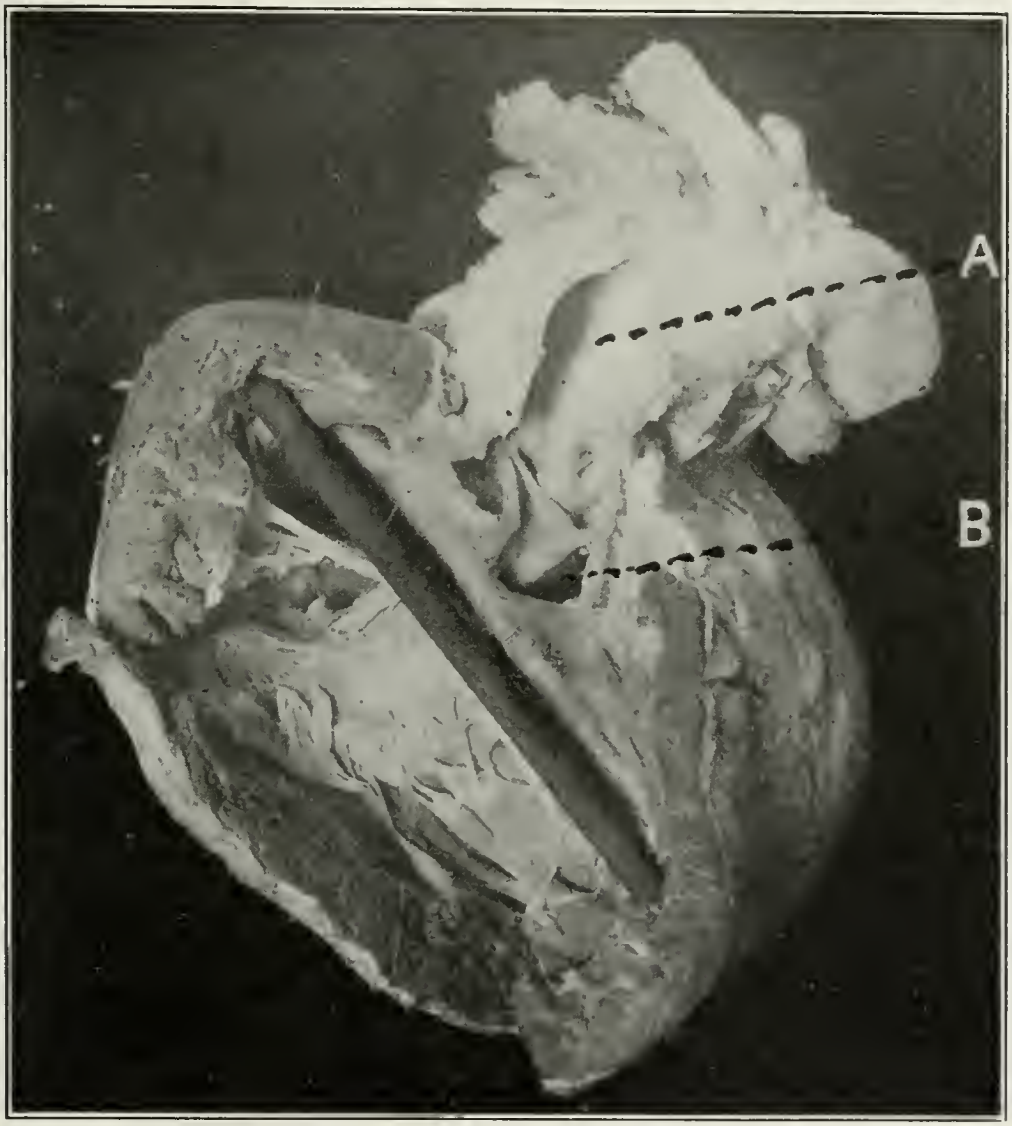

Fig. 4.—Heart cut open, showing *A*, single artery and *B*, opening between ventricles.

down to between 100 per cent. and 115 per cent. by the Sahli apparatus. The red corpuscles ranged between nine and eleven millions and the white corpuscles between 9,000 and 10,000. The blood pressure, by the Tycos apparatus, was 120 in systole and 50 in diastole, giving a pulse pressure of 70.

The temperature rose again after the appearance of the murmur, but after a week dropped to normal in the morning with an evening exacerbation to

from 100 to 101 F. By the middle of January the systolic murmur had almost disappeared and the diastolic murmur had become much fainter. The general condition continued unchanged, as did the condition of the heart. The patient died suddenly Feb. 10, 1915, presumably as the result of an embolus.

A positive diagnosis of congenital heart disease was made when he was first seen. The malformations with which the symptoms were reasonably consistent were absence of the ventricular septum, transposition or irregular origin of the great vessels and pulmonary atresia with some secondary malformation. There ought not to have been any second pulmonic sound, however, if there was pulmonic atresia, and it should have been accentuated if there was simply a transposition of the vessels. The most reasonable diagnosis, therefore, seemed to be absence of the ventricular septum. A single vessel coming from a single ventricle had been mentioned but had not been seriously considered.

Unfortunately, it was possible to obtain only a partial necropsy. The heart and lungs alone were examined. The results of the examination by Dr. S. Burt Wolbach are as follows:

Gross anatomical diagnosis:

1. Complete congenital atresia of pulmonary artery.
2. Congenital defect of interventricular septum.
3. Persistent ductus arteriosus.
4. Acute vegetative endocarditis.
5. Thrombosis of ductus arteriosus.
6. Patent foramen ovale.
7. Dilatation and hypertrophy of right ventricle.

The heart is greatly enlarged and weighs 130 gm. (normal, 105 gm.). The general shape is that of a normal heart, but the right border is rounded and it is evident that the right ventricle is enlarged. The auricles are in their normal position. The appendage of the left auricle, however, is narrow and projects as a curved process, 2.5 cm. long and 0.5 cm. broad.

There is a single arterial trunk which arises at the base of the ventricles anterior to the auricles. The tips of the right and left auricular appendages appear on their respective sides of this vessel. On opening the heart it is found that this vessel arises from both ventricles. Its orifice is directly above the interventricular septum, which is deficient. This deficiency corresponds to that resulting from the absence of the membranous portion of the septum. Its upper border is the attachment of the anterior segment of the mitral valve. Its right pillar extends to the base of the right anterior segment of the semilunar valve of the arterial trunk, while its left pillar extends to the junction of the left anterior and the posterior segment of the valve. The size of the interventricular opening is 2 by 1 cm. (after hardening). The arterial trunk is apparently effectively guarded by the semilunar valve, a posterior and a right and left anterior. The free edges of these segments are slightly thickened and covered with pale, grayish, friable granulations. The coronary arteries take their origin behind the posterior and the left anterior segments. The size and shapes of the segments are those of a normal aorta in a heart of this size. The circumference is 8 cm. The arch corresponds to the arch of the aorta and is continuous with the descending aorta. The vessels given off are in the order named; the innominate, left common carotid, a small thin-walled ascending vessel and a left subclavian. At the location of the ductus arteriosus a large vessel takes origin by a short trunk, which divides into a right and left pulmonary artery. From this trunk running down along the main arterial trunk,

is a thin-walled, small calibered vessel, 2 to 3 mm. in diameter. This vessel ends blindly, gradually disappearing to a point in the myocardium between the posterior and left anterior segments of the valves of the main arterial trunk.

The orifice of the pulmonary trunk into the arch of the main arterial trunk is 0.4 cm. in diameter, and nearly wholly occluded by a firm, grayish-red clot. This clot is cylindrical in shape, 0.4 cm. long, and attached firmly over one-half its circumference (organized).

The mitral and tricuspid valves are normal in appearance. The mitral measures 8.5 cm. in circumference at the attachments of the segments, and the tricuspid valve measures 10 cm.

The venous orifices in the auricles are normal in number and position. The foramen ovale is patent by an oblique passage.

The endocardium is normal, except for the aortic changes noted and a few minute vegetations on the inferior border of the opening between the two ventricles.

The myocardium is firm, of normal color and consistency. The left ventricular wall averages 1 cm. in thickness; the right is 0.9 cm.

70 Bay State Road.

DISCUSSION

DR. HAND: Dr. Morse's specimen is very unusual in the nature of the defect of the septum between the ventricles. At least, according to literature, the common site for such defects is in the muscular wall, and not in the membranous portion, where this defect seems to be. In the few instances in which I have seen the lesion, it has always been in the muscular, rather than the membranous part.

DR. NORTHRUP: I think that a couple of years before Dr. Morse was born I presented such a case as this before the Pathological Society of New York. I believe it was the same thing; and if he would like another case of the kind to add to this of his, I will try to look it up. Dr. Koplik reminds me that in the archives of the College of Surgeons I could probably find it, and I will add it to the list.

DR. HOWLAND: I saw the child during life and certainly the murmur was a very slight one. It was diastolic, while the murmurs that one hears associated with congenital cardiac disease are almost always systolic.

We had a discussion as to what the condition might be at that time, and came to the conclusion that it was probably an acute endocarditis grafted on congenital heart disease. I have seen one or two other cases of congenital heart disease which we were unable to follow, that had only diastolic and no systolic murmurs. I have wondered what the lesion might be in these cases.

A CASE OF ACUTE MYELOGENOUS LEUKEMIA IN AN INFANT

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The case here reported as being of unusual interest, is that of a female infant, L. F., Hebrew, 9 months of age, who was admitted to the Thomas Wilson Sanitarium, July 11, 1913.

Family History.—The father and mother were both well, aged 36 and 33 years, respectively. They had lost four other children in infancy, one from scarlet fever and three from "summer complaint." The patient was the only living child. There was no history of syphilis or of tuberculosis. The parents were apparently in comfortable circumstances and the hygienic condition of their home was described as "good."

Past History.—The patient's birth was normal; weight 7½ pounds. She was exclusively breast fed for six months and for the last three months a whole milk mixture had been used as a supplementary feeding. The patient had never been ill before and had gained steadily.

Present Illness.—The baby is said to have "caught cold" two weeks previously. She was better, however, and the acute symptoms of the present condition began only five days before admission, suddenly and without prodromata. These symptoms consisted principally of nausea and vomiting almost immediately after taking food, with frequent retchings between feedings. Shortly after the onset, diarrhea of moderate severity began, the stools being described as fecal, fluid and mucous, but with no blood; five to eight in twenty-four hours. There was some continuous fever and a cough that had persisted for two weeks.

Physical Examination.—This, for the most part, was unimportant. Patient was fairly well nourished, somewhat pale and exceedingly fretful. Weight 15 3/16 pounds. The throat was clear, and the lungs were negative, excepting for a few scattered moist râles. Heart sounds were clear.

The abdomen was soft, very slightly diffusely tender, and there was *no enlargement of spleen.* The edge of the liver was palpable. There was *no general glandular enlargement;* the reflexes were active and the skin clear. The temperature on admission was 102 F. The most prominent symptom during observation was almost constant nausea and vomiting. The expulsion of gastric contents was not forceful in character. Retching persisted if the patient was aroused during starvation, and after breast milk as well as after various cow's milk and cereal mixtures. The temperature remained continuously over 100, and in the last four or five days frequently reached 103, once 105. The von Pirquet reaction was negative. The ear drums were smooth and glistening. The vomiting continued to be the dominating symptom. The stools were fecal in character and not more than three to five in twenty-four hours. The child lost con-

tinually in weight, was irritable when disturbed but not stuporous. There was little change in her condition for ten days. At that time her condition became decidedly more serious. The vomitus developed a fecal odor. The stools then were four in twenty-four hours and fecal in character. There were no other symptoms suggesting intestinal obstruction. The patient became progressively worse. A leukocyte count made at this time showed a great increase in white cells, which numbered nearly 200,000 per cubic millimeter. Smears were made but were not studied for several days. The patient twelve days after admission had a number of general convulsive seizures ending in coma and death. Necropsy was refused.

The exciting cause of the vomiting was not determined during life. The symptoms seemed to point to gastro-intestinal intoxication with unusual gastric irritability. The differential count of the leukocytes showed the presence of a large number of myelocytes from the bone marrow and suggested the diagnosis of acute myelogenous leukemia.

The report of Dr. W. A. Baetjer, of the Clinical Laboratory of the Johns Hopkins Hospital, to whom the specimen of blood was referred is as follows:

The leukocytes, 200,000.

Differential count: Wilson stain, 500 cells.

	Per Cent.		Per Cent.
P. M. N. cells	47.0	Myelocytes	....
P. M. E. cells	4.2	Neut.	18.0
P. M. B. cells	0.0	Eos.	1.6
Lymph.	28.6	Bas.	0.2
L. Mono.	0.0	Myeloblasts	0.4
Trans.	0.0	Nuo. R. B. C.	0.0

Blood Picture.—Moderate secondary anemia; no marked reduction in number of R. B. C.; very few nucleated reds. Platelets about normal; no striking fragility of the cells. P. M. N. young, often with scanty granulation and showing all transitions to myelocytes. Most of the myelocytes have the atypical, coarse purple granules usually seen in young forms. Many others show a narrow band of basic protoplasm with variable granulations. The lymphocytes are mostly of the typical small variety; there are, however, a fair number of larger forms with deep basic protoplasm.

Picture resembles chronic myeloid leukemia, except for the predominance of atypical granulations in most of the myelocytes and in the high per cent. of small lymphocytes, probably due to the age of the patient (9 months). Diagnosis: Acute myeloid leukemia. Type, clinically acute. Blood picture resembling chronic myeloid leukemia with high percentage of lymphocytes due to age.

It is not the object of this report to enter on any discussion of myeloid leukemia as a pathologic process, but simply to place this case on record as the youngest case we have been able to find in which the blood picture was characteristic. The youngest patient in a series of sixty cases of myeloid leukemia, reported by Naegeli, was 4 years of age. Besides the extreme youth of the patient, the rapid course of the disease, less than three weeks, is noteworthy.

There was no enlargement of the lymphatic glands or of the spleen and no evidence of hemorrhage or of necrosis of the mucous membranes. The symptoms apparently were referable to the gastro-intestinal tract.

The great number of leukocytes in the circulating blood, 200,000 per cubic millimeter, was too many to be accounted for by a possible focus of infection, and directed attention to a further study of the blood. While it is possible to have perhaps as high as 15 per cent. of myelocytes in acute infections, the cells are of the typically neutrophilic variety. In this case, however, the atypical granulations seen in the neutrophilic myelocytes as well as the presence of eosinophilic and basophilic varieties, is good evidence of true primary disease of the blood-forming organs.

THE HYDROGEN-ION CONCENTRATION OF THE GASTRIC AND DUODENAL CONTENTS IN CHILDHOOD

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Until recently we have been satisfied with the determination of the acidity of the body fluids by the titration method. The newer advances in physical chemistry have shown us how unsatisfactory this method really is when compared with the methods of determination of the hydrogen-ion content.

Titration simply tells us how much of an alkali of known strength must be added to a solution to neutralize the acid present, or vice versa. Titration, therefore, determines only the acids plus the salts of weak bases in a solution. It is not a measure of the degree of acidity or alkalinity of that solution. This is shown by the fact that strong and weak acids or alkalies may act in the same manner, according to titration results, and salts of alkaline or acid character may give equal results by this method. The process of neutralization, as carried out by titration, therefore, is no measure of the degree of acidity or alkalinity of a solution. Expressed physicochemically, it does not determine the hydrogen-ion or hydroxyl-ion concentration on which the true chemical reaction, and therefore the ferment action, is dependent.

Pure anhydrous HCl does not have an acid reaction. It is only when it is dissociated, as when dissolved in water, that it has acid properties. Michaelis and Davidsohn[1] give the following illustrations:

> If we titrate 10 c.c. of n/10 HCl with phenolphthalein, 10 c.c. of n/10 NaOH are required for neutralization. If we titrate 10 c.c. of n/10 acetic acid, we need exactly the same amount of n/10 alkali. Still nobody doubts that the hydrochloric is a much more strongly acid fluid than the acetic acid. If, on the contrary, we titrate the same fluids with methyl orange as an indicator, the HCl solution still requires 10 c.c. of the alkali, but the acetic acid shows not the least acid reaction. Without multiplying examples, it may be readily seen from the above that the titration acidity and the true acidity are altogether

1. Michaelis and Davidsohn: Ztschr. f. Exper. Path. u. Therap., 1910-11, viii, 398.

different things. The acidity of titration is a wholly artificial conception, which rests on the manipulation of the titration and the artificial changes which titration brings about. Titration may be used for the purposes of chemical analysis under definite simple conditions, but it gives no information concerning the true acidity, that is, concerning the hydrogen-ion concentration of the original solution. For instance, in spite of the fact that the titration acidity against phenolphthalein of equivalent solutions of hydrochloric and acetic acids is the same, their true acidities differ enormously. This is because 91 per cent. of n/10 HCl breaks up into its component ions, while only 1.4 per cent. of n/10 acetic acid is dissociated."

This is well expressed by Schade[2] when he says: "Titration measures the *sum* of the actual and potential ions. It gives no estimation of the actual ions themselves, which can be determined by physicochemical means only."

The importance of the determination of the true acidity lies in the fact that the action of the ferments depends on the hydrogen-ion concentration of the digestive fluids containing them.

The interesting study of the gastric contents by Michaelis and Davidsohn contains a discussion of the history of the subject with references to the literature as well as their own findings. They found that the optimum acidity for peptic digestion lies at n/60 HCl, or a hydrogen-ion concentration of about 0.016. They found that the minimum acidity at which peptic digestion occurs is about n/100 HCl, that is, n/1 acetic acid, or more correctly 0.0014 n H-ion concentration. Sorenson,[3] however, obtained peptic digestion at 0.0001 n.

The first satisfactory study on the hydrogen-ion concentration of the gastric juice of children was published by Allaria[4] from the University of Turin. He found the hydrogen-ion concentration of the gastric juice of infants to be from about one-fiftieth to one-hundredth of that in the adult. He found a much greater difference between the degree of active and potential acidity than in the adult. On account of the very low true acidity, he considered that conditions were very poor in the infant's stomach for peptic digestion, and believed that the function of the infant stomach is confined, as far as the digestion of

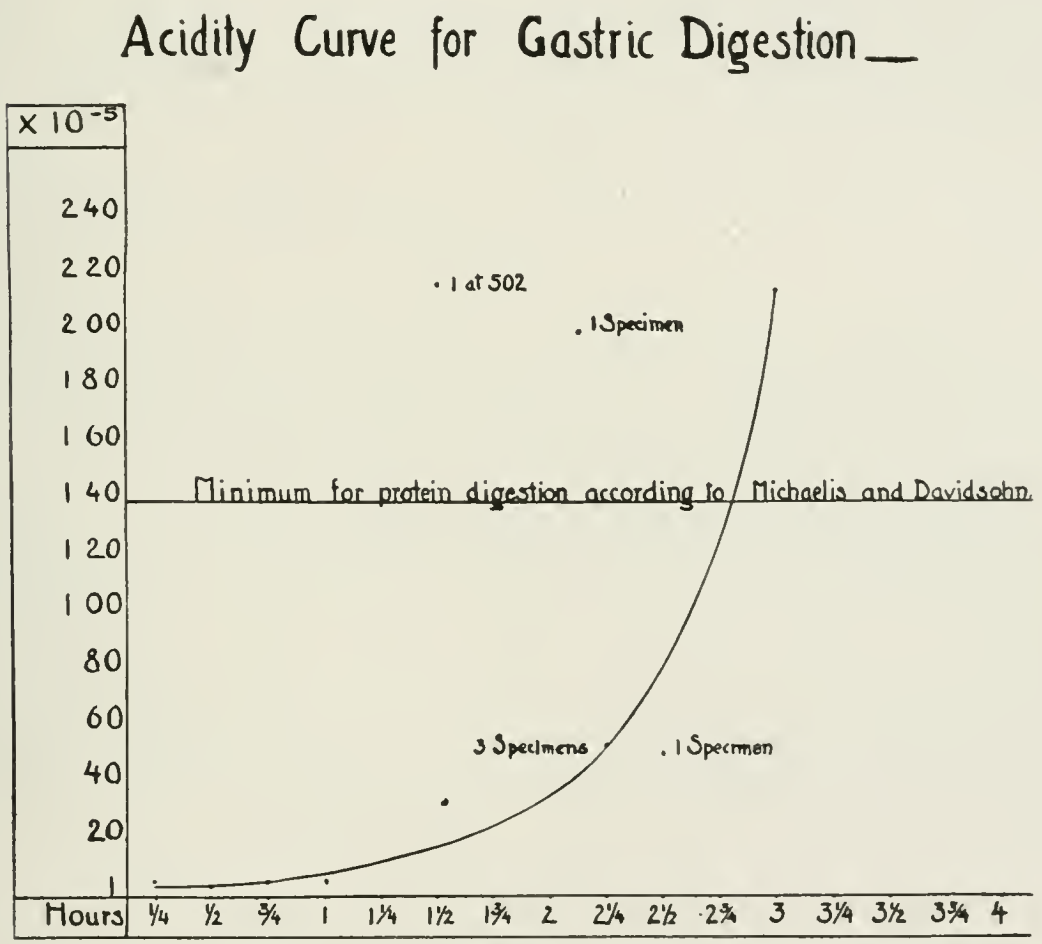
2. Schade: Brugsch and Schittenhelm. Technik der speciallen klinischen Untersuchungs. Methoden, Urban and Schwarzenberg. Berlin and Vienna, 1914, ii, 949.

3. Sorenson: Biochem. Ztschr., 1909, xxi, 131.

4. Allaria, G. B.: Jahrb. f. Kinderh., 1908, lxvii, 123.

proteins is concerned, to the preparation and beginning of digestion only, which is carried out further in the intestine. On the same ground, he considered the gastric juice of infants to have a very weak antiseptic action.

Davidsohn[5] has studied this subject very carefully. He came to the conclusion, in both the naturally and artificially fed healthy child, that the low acidity does not permit of practically any peptic digestion



in the stomach. He believes that the two most important functions of the gastric juice are the splitting of fats and coagulation of milk. He found that the acidity at the height of digestion is about 1×10^{-5}.

Salge,[6] working with the indicator method, confirmed Davidsohn's finding of low acidity.

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5. Davidsohn, H.: Ztschr. f. Kinderh., 1911, ii, 420; 1912, iv, 408 and 1913, ix, 470; Monatschr. f. Kinderh., 1914, xiii, 182.
6. Salge, B.: Ztschr. f. Kinderh., 1912, iv, 171.

Hahn,[7] from work done by him in Davidsohn's laboratory, draws the following very interesting conclusions:

1. The determination of the hydrogen-ion concentration is the only rational method of measuring gastric acidity in infants.
2. The hydrogen-ion concentration, $(H) = 1 \times 10^{-5}$, is the normal reaction of the stomach contents at the height of digestion for infants fed on ⅓ cream-milk and ⅔ milk.
3. $(H) = 1.0 \times 10^{-5}$ is the optimum reaction for rennet and gastric lipase; pepsin is inert at this reaction.
4. The important processes in the gastric digestion of infants are the coagulation of milk by rennet and the splitting of fat by gastric lipase; the peptic digestion of casein is unimportant for the infant.
5. In infants from 1 to 4 months old fed on ⅓ cream-milk, the lipase content increases with the age of the infant.
6. In infants from 4 to 12 months old fed on ⅔ milk, the content of all gastric ferments is greater than in infants from 1 to 4 months old on ⅓ cream-milk."

Huenekens,[8] of the University of Minnesota, Pediatrics Division, also working in Davidsohn's laboratory, found that the reaction of the stomach contents of the children which he examined, from the ages of 9½ months to 5 years, was consistently weakly acid, and in artificially fed infants corresponded to a $(H)=1\times10^{-5}$.

Schackwitz[9] found somewhat higher values in some of his analyses, but Davidsohn attributes this apparent discrepancy to the former's method of obtaining small portions of the stomach contents only, instead of the whole content as in Davidsohn's work. He believes that the higher values may have been obtained from nonrepresentative portions derived from the content lying close to the gastric mucosa. This he supports by Tobler's findings in regard to the varying acidities found in different portions of the stomach contents.

METHODS

There are two common methods for determination of the hydrogen-ion concentration of fluids, both of which were used in this work.

The first is the accurate gas-chain method.

Principle: If a metal is dipped into water, that metal shows a continuous tendency to send its substance, as ions, into the fluid until

7. Hahn: Am. Jour. Dis. Child., 1914, vii, 305.
8. Huenekens, E. J.: Ztschr. f. Kinderh., 1914, xi, 297.
9. Schackwitz, A.: Monatschr. f. Kinderh., 1914, xiii, 73.
10. Tobler, L.: Ztschr. f. Kinderh., 1912, v, 85.

Data Concerning H-ion Concentration Among Infants

Date	Name	Organ	Hours After Meal	Days Old	Ph.	H.10^{-5}	Remarks
2/18	Lagace	S	1	7	4.1	7.95	Breast-fed
2/19	Anderson	S	¾	120	5.39	5.37	One-half milk; one-half oatmeal
2/20	Carr	S	1	6	5.73	1.86	Breast-fed
2/20	Nikkole	S	1	7	5.56	2.75	Breast-fed
2/20	Everson	S	1½	10	4.84	14.	Breast-fed
2/22	Verain	S	2½	6	4.5	31.	Breast-fed
2/	Carr	S	2¼	8	4.1	79.	Breast-fed
3/15	Von Verdo	S	1	8	5.26	5.5	Breast-fed
3/15	Jacks	D	5	11	6.84	00.145	Breast-fed
3/24	Besserude	D	3	...	4.15	70.8	Breast-fed. Much bile
3/26	Capman	D	4	8	6.03	0.933	Breast-fed. Bile
3/27	Cain	D	1½	...	4.	10.	Breast-fed
3/29	Hoppe	S	1	28	5.	1.	Breast-fed
4/1	Hoppe	S	1	31	5.1	07.95	Breast-fed
4/2	Cain	S	¼	14	5.2	06.31	Breast-fed. Tinged with bile
4/2	Cain	D	2	14	5.2	06.31	Breast-fed
4/3	Byrne	S	1½	4	4.7	20.	Breast-fed
4/3	Seidel	D	4	9	4.3	50.2	Breast-fed. Bile. X-ray
....	Seidel	S	3	...	2.9	2000.	Tinged with bile. Few fine curds. Breast-fed
4/6	Byrne	S	3	8	3.45	355.	Breast-fed
4/7	Byrne	S	3	9	3.	100.	Breast-fed
4/7	Byrne	D	4	9	4.1	79.5	X-ray. Breast-fed
4/7	Seidel	S	½	13	5.65	2.24	Breast-fed
4/7	Seidel	S	1¾	...	4.35	44.7	X-ray. Breast-fed
4/8	Seidel	S	4	14	2.1	7950.	Breast-fed
4/8	Linn	S	½	6	5.3	05.0	Breast-fed
4/8	Linn	D	1	6	4.6	25.1	Bile stained. Breast-fed
4/9	Seidel	D	2¾	15	5.3	5.0	Bile stained. Breast-fed
4/10	Linn	S	2	8	3.9	200.	Breast-fed
4/12	Linn	S	1½	...	2.1	7950.	Breast-fed
4/12	Michel	S	2¼	6	3.7	200.	Stomach had emptied into intestine. Breast-fed
....	Michel	D	2½	...	4.5	31.6	Much bile. Breast-fed
4/13	Michel	S	1½	7	4.3	50.2	Breast-fed
....	Michel	D	2	...	5.1	7.9	Much bile. Few curds. Breast-fed
....	Loan	S	2¼	7	4.3	50.2	Breast-fed
....	Loan	D	2½	...	4.9	20.	Much bile. Breast-fed
4/14	Loan	S	1¾	8	4.35	44.7	Breast-fed
4/14	Loan	D	2¼	...	4.5	31.6	Breast-fed
4/14	Ollikainen	S	1½	9	4.	10.	Breast-fed
4/14	Ollikainen	D	1¾	9	5.	1.	Breast-fed
4/14	Wood (adult)	S D	...	Adult	7.7	0.02	Pernicious anemia
4/15	Loan	S	2½	9	4.3	50.2	Breast-fed
4/15	Morgan	S	1½	6	3.3	502.	Breast-fed
....	Morgan	D	2	...	4.2	63.1	Bile stained. Breast-fed
5/10	Falconer	S	40 min. after birth	...	4.7	20.0	Had taken no food
5/13	Hagan	S	...	1	....	.....	$H^+ = .005$. Had not taken nourishment

the pressure caused by these ions reaches an equilibrium. Hydrogen acts as a metal in this respect and the sending off of the ions is accompanied with the production of an electrical potential. The hydrogen ions bear a positive charge. They therefore carry positive electricity into the solution and leave a negative charge behind with the molecular, that is undissociated, hydrogen at the electrode. The sending off the hydrogen ions from the electrode is dependent on the number of hydrogen ions already present in the fluid to be examined. The more hydrogen-ions a solution already contains, the less the sending off of the ions from the molecular hydrogen, and therefore the less will be the electrical potential produced; that is, the less will be the negative charge of the molecular hydrogen. Therefore, solutions with different hydrogen-ion concentration will produce different electrical potentials. Now, if two hydrogen masses are used as electrodes to produce an element, as in any electrical cell, they must be dipped into solutions of different hydrogen-ion concentration in order to produce a current. This current will be proportional to the difference in the hydrogen-ion concentration of the two solutions. If the conditions are so arranged that the hydrogen-ion concentration of one solution is known, and the amount of current produced be measured, the hydrogen-ion concentration of the solution to be examined can be directly determined.

METHOD

This study was carried out by the gas-chain method, at first in Davidsohn's laboratory with the apparatus devised by Michaelis, but most of it was done with a modified apparatus set up, as shown in the chart, by Dr. McClendon,[11] Instructor in Physiology at the University of Minnesota, and by whom the determinations given were made.

INDICATOR METHOD

As the above apparatus, although the only accurate method for the purpose of research work, is hardly available to clinicians in general, the simpler indicator method has been devised for certain fluids. This method depends on the fact that various indicators give certain

11. McClendon, J. F.: New Hydrogen Electrodes and Rapid Methods of Determining Hydrogen-Ion Concentration, Am. Jour. Physiol., July, 1915.

colors with different hydrogen-ion concentrations. Davidsohn has calibrated a series of indicators for the gastric contents of infants by the gas-chain method and has devised the accompanying table:

TABLE OF INDICATORS FOR GASTRIC CONTENTS OF INFANTS BY GAS-CHAIN METHOD

$H \times 10^{-5}$	0.3	0.3-1.0	1.0-7.0	7.0-20.0	20.0-60.0
Methylorange paranitro-phenol litmus	Yellow dark green bluish violet	Yellow bright green violet red	Yellow colorless pink	Orange colorless pink	Orange red colorless pink

I have used this indicator method with the gastric content and confirmed the results of Davidsohn and Salge, finding the gastric contents of infants during the height of digestion to be usually equal to a hydrogen-ion concentration of 10^{-5}.

The results in the accompanying chart were all obtained with the gas-chain method.

The course of acidity during digestion may best be seen in the curve of means. The hydrogen-ion concentration remains very low—10^{-5} for the first hour to hour and a half—and then begins to rise gradually until after the second hour. There is then a very steep and high elevation until at the end of the three hours $[H]=200\times10^{5}$ may be reached. This rise occurs, however, after the height of gastric digestion. The high concentration was not found in stomachs which contained any considerable amount of food.

After the food had left the stomach, the acidity was found to go to very surprising heights, as shown by the following: At the end of three hours, stomach almost empty, contents slightly bile tinged, $[H+]=2000\times10^{-5}$; four hours after ingestion of food, with the stomach also almost empty, and bile tinged, $[H+]=3800\times10^{-5}$. One almost empty stomach showed a hydrogen-ion concentration of 7950×10^{-5}.

The duodenal contents were obtained by means of the Hess catheterization method. Only those cases in which the catheter was evidently in the duodenum by the clinical signs, or by roentgen examination, were used.

The hydrogen-ion concentration was as follows:

Hours After Food	H-ion Concentration	Hours After Food	H-ion Concentration
1½	10.0×10^{-5}	2½	31.6×10^{-5}
1¾	1.0×10^{-5}	2¾	5.0×10^{-5}
2	6.31×10^{-5}	3	70.8×10^{-5}
2	7.9×10^{-5}	4	0.9×10^{-5}
2	6.3×10^{-5}	4	50.2×10^{-5}
2½	31.6×10^{-5}	4	79.5×10^{-5}
2½	20.0×10^{-5}	4	25.1×10^{-5}

When we recall the fact that the neutral point is [H+]10-7 or 0.01×10^{-5}, it will be seen that the duodenal content is consistently, but not highly acid, averaging 28.7×10^{-5}.

In closing, I wish to thank Dr. Rood Taylor, Teaching Fellow in Pediatrics, who collected the specimens, for assistance throughout the work.

SUMMARY

From this work the following definite conclusions may be drawn:

1. The results of other observers, which show a low acidity of the gastric contents of infants during the height of digestion, is confirmed.

2. The sharp rise of acidity of the gastric contents towards the close of digestive period is shown.

3. The gastric contents of a new-born infant before food was taken was very acid.

4. The duodenal contents of infants obtained by the Hess method are not alkaline, but show a hydrogen-ion concentration of from 79.5 to 0.9×10^{-5}.

DISCUSSION

DR. GERSTENBERGER: I did not hear Dr. Sedgwick say what food had been given—whether the children were fed on an artificial food or on breast milk.

DR. SEDGWICK: One was artificially fed and the others all breast fed. We tried to get normal conditions.

DR. GERSTENBERGER: Did you find a decided difference between the artificially fed child and the breast-fed children?

DR. SEDGWICK: No.

DR. GERSTENBERGER: I was thinking of the work of Aron, who found that there was a great difference in the acid-binding powers of breast milk and cow's milk. I was going to ask whether the acid condition found in the duodenum might not be explained by the manner in which the duodenal juice is obtained, namely, by means of a catheter passing through the pylorus into the duodenum.

DR. SEDGWICK: In answer to Dr. Gerstenberger's last question I would say that I was very careful, on that account, to state that for this study the duodenal contents were obtained by the Hess method. That is the only fact that we have. In regard to variations in acidity caused by collecting the duodenal contents by other methods, I can give no opinion, as we have used no other method.

SOME INTERESTING FACTS PLAINLY BROUGHT OUT BY A CHART METHOD OF STUDYING AND MANAGING CASES OF DIABETES MELLITUS IN CHILDREN

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Charts give one in the easiest and quickest way a fund of information concerning a case. In many febrile diseases valuable impressions are often gained if the whole course of the temperature is before one's eyes. This applies to diseases of long duration, such as diabetes mellitus, if it can be simply charted. This can be done, and the ones I show contain all the information necessary, and yet are not too cumbersome. They tell you what you have done, when you did it, and the results.

The upper half of my charts shows in unbroken lines the number of grams of the three food elements ingested, and their total caloric value. The lower half shows in broken lines the urine analyses, and hence the condition of your patient on the selected diet.

For further ease of reading, colored crayons are used. The continuous red line above shows the number of grams of carbohydrates ingested, and the lower broken red line shows the amount of sugar in the urine. The upper broken black line shows the proteins ingested, and the lower broken line the amount of urea.

The unbroken lines above of violet and blue show, respectively, the amount of fat ingested, and the caloric value of the diet. The broken lines below in brown, green and violet show the amount of urine, of ammonia-nitrogen, and of acetone eliminated. To save breadth of chart the figures on the side line must be multiplied by 100 for the amount of urine. Because the amount of ammonia-nitrogen and acetone are too small for charting purposes they must be multiplied by ten and twenty, respectively, and then charted. With these few points of explanation understood one can at a glance grasp the whole situation.

In the first chart shown skimmed milk was first given, because we were told the child of eight years could not easily tolerate fats. This allowed us very definitely to study her carbohydrate tolerance in the

form of milk sugar. Because the amount of sugar fell on skimmed milk from 27 gm. in the first twenty-four-hour sample to 5.5 gm., we definitely learned that her milk sugar tolerance was poor. Not till all the milk was prohibited was she sugar-free. We learned, as shown, that she could be sugar free on meat, eggs, and butter, but as soon as a fodder food, such as onions, was given, she passed 4/10 as much sugar in the urine as she had ingested carbohydrates in the onions. While she tolerated meat and eggs well, when fish was added the amount of sugar which appeared was about 1/6 of the amount of fish ingested. This was peculiar.

The acetone was always present and gradually increased on all diets given. This alone showed, that in spite of the fact she was sugar-free, she was losing ground. As the acetone increased so did the ammonia-nitrogen, and this was another sign of unfavorable progress.

As regards Chart 2, the following points are of interest: With neurotic tendencies and a precocious intellect, this girl of 10 years was a victim of cyclic vomiting. We have charted four attacks of vomiting, and before three of these sugar appeared. Naturally it quickly disappeared on the starvation of persistent vomiting. It has consequently occurred to me that in cases of cyclic vomiting we might find sugar just before an attack more often than we suspect, due probably to the same faulty metabolism, which causes the vomiting. We tested the fat tolerance twice, as shown on the charts. The first time we gave 145 gm. and promptly sugar appeared. The second time we gave 165 gm. per day for six days. Soon sugar (2.50 gm.) appeared and decreased to 1.00 gm., when the carbohydrates were reduced much below a well known carbohydrate tolerance. After the high fats were lowered below a well known tolerance, the sugar not only persisted but rose to 5 gm., and she had a vomiting attack. This late rise in sugar and the vomiting were then, without doubt, due to the damage done by the fats. I could then conclude, (1) that an excess of fat may in itself cause sugar to appear, and (2) that high fat may be a cause of cyclic vomiting.

This second statement has been proved in her case, because, since her fats have been kept at 100 gm. or less per day, she has not vomited. As regards the acetone, the fats caused it to increase.

I mentioned above that the child was a neurotic. One day, as shown, sugar appeared while we were testing the carbohydrate tolerance. As no clear cause was seen we kept on increasing the carbohydrates, and in spite of this increase the sugar disappeared. On very thorough investigation we learned that the sugar was undoubtedly due to the worry of a guilty conscience, because she had been for weeks doing something she knew was not right. This shows that an unbalanced nervous system can produce sugar.

The chart in her case shows no idiosyncrasy to any of the different starches, proteins, or fats. They were all equally tolerated. Her tolerance to milk sugar in milk and levulose in fruits was only fair, and no different from any other starch.

The third chart I do not show. At varying intervals I give the usual starvation or water day. This boy of four years on one of these days vomited, with nervous manifestations, going into more or less of a stupor. This I experienced once in another child, except that the second child was delirious. No cause have I found for such an upset in either case.

SUMMARY

Charts aid materially in the study of a case of diabetes.

In one of my cases sugar was caused (1) by high fats, and (2) by mental anxiety.

In another, fish caused sugar, while all the other proteins were fairly well tolerated.

In one case high fats caused cyclic vomiting.

Sugar may appear before cyclic vomiting attacks more often than we suspect.

THE DIFFERENTIAL DIAGNOSIS OF PYLOROSPASM AND HYPERTROPHIC STENOSIS OF THE PYLORUS

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Perhaps a better title for what follows would be, a study in psychology, as shown by the writer's changing attitude toward the treatment of pyloric stenosis.

The abdominal region in infants and young children presents some very difficult problems in diagnosis. These problems arise with decided frequency because of the greater activity of the alimentary tract in early life, due to the demands on it to furnish means for the vastly greater growth which occurs at this time than in the later periods of life. With this greater activity, disturbances of function are prone to occur, which, while yet functional may closely resemble some one or more of the organic affections.

Typical instances of disease do not as a rule present any difficulty in diagnosis, but patients do not by any means always present all of the classical symptoms; or, if they do, others may be superadded which obscure their importance. So, when we read in medical literature of some new disease and begin to look for it, we are soon confronted with cases more or less accurately resembling that disease. Of these simulations none are more puzzling than that between so-called spasm of the pylorus and congenital hypertrophy with stenosis.

In the first place, it is well to discuss what is meant by spasm of the pylorus, a term which is newer in medical literature than that of hypertrophic stenosis. It is being used in medical literature rather frequently as though it represents a distinct clinical entity, the diagnosis being made in those cases which are suspected of being stenosis but which recover under medical treatment. I believe that the underlying condition in many cases is probably not so much a failure of the pylorus to relax at the proper time as it is a gastric indigestion due generally to improper feeding. Still, I have seen a few infants whose vomiting occurred after almost every feeding, associated with obstinate constipation, failure to gain in weight, dilatation of the stomach and

visible peristalsis; while there was evidently gastric indigestion (in spite of the feeding being at the breast) it did seem as though the vomiting did not depend entirely on the indigestion, but that either a tonic condition of the pylorus, or a certain amount of hypertrophy, or a combination of the two, also existed, allowing very little of the stomach contents to pass into the duodenum.

The first case of this kind which came under my care (some time after having witnessed an operation of pyloroplasty in an infant with a distinct hypertrophy of the pylorus, the infant succumbing in twenty-four hours) was that of a female infant (Chart 1) weighing 6 pounds, 2 ounces at 3¾ months of age; the history was that up to 2 months

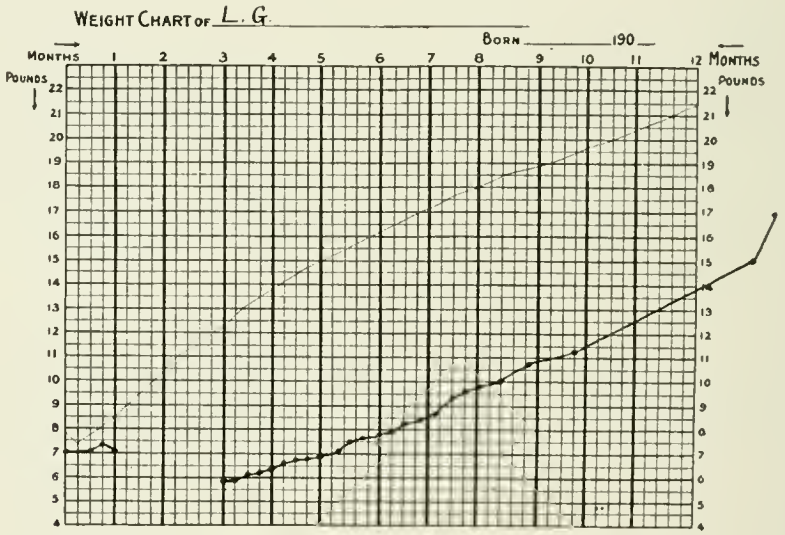

Chart 1.—Frequent projectile vomiting; constipation; no tumor felt; slow progress without operation.

of age the baby had been breast fed exclusively, but vomited almost every nursing and never had a spontaneous movement of the bowels; after the second month various modifications of milk (cream, milk, whey, buttermilk) had been given, alternating with the breast feedings, without any improvement. This history was very suggestive of pyloric stenosis and it was a surprise on examination to be unable to demonstrate a small lump anywhere in the abdomen; the stomach did not seem dilated until after a feeding, when the upper part of the abdomen became prominent, but I could never satisfy myself that peristalsis was visible (patient seen at office only). After pondering over the advisability of operation, I was influenced by the age of the patient and the fact that an enema sometimes brought away fecal matter, to

try dietetic care for a time longer. Progress was very, very slow but steady, except for one loss of 2 ounces, so that in her second year, the state of nutrition finally became satisfactory.

It is exceedingly difficult to know how to classify this case. During its progress I was of the opinion that it was a genuine case of pyloric hypertrophy with a sufficient degree of patulousness to allow of slow general development, until either the body grew up to the hypertrophy and it made a relative disappearance, or it actually disappeared, if, indeed, such is ever the case, perhaps analogous to the dilatation which ultimately succeeds hypertrophy of the heart-muscle.

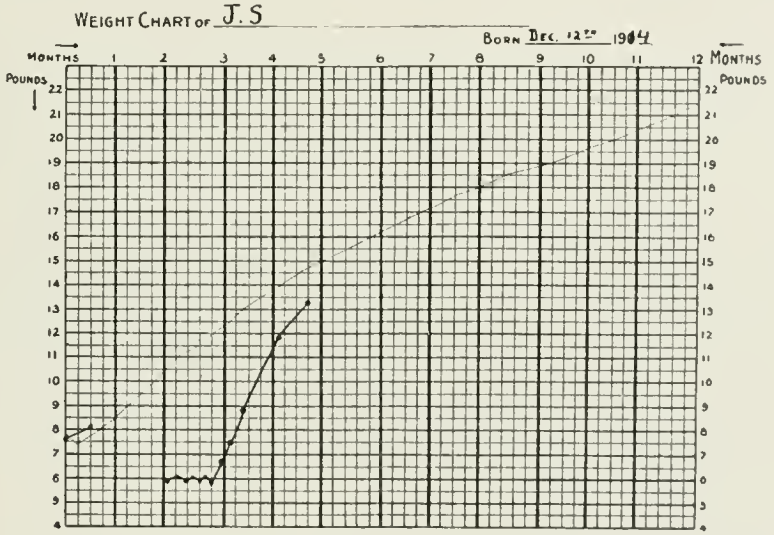

Chart 2.—Pyloric stenosis; failure to gain in third month; rapid gain after operation.

The question also arose as to whether it was a pure case of pyloric spasm, or one of gastric indigestion with spasm, the indigestion being gradually overcome by the dietetic measures, and the spasm ceasing with the removal of the exciting cause.

Following this case, five other patients were seen, three breast fed and two on the bottle, making slow recoveries, but more promptly than the first. In four of these, peristalsis was visible and in one of them a skiagraph showed complete retention of bismuth in the stomach until it was vomited. A tumor could not be felt in any of them. The one which did not show visible peristalsis, although obstinately constipated and vomiting after almost every feeding, was probably an instance of indigestion, for with a change from the evidently inappro-

priate milk from the mother's breast, to a modification of cow's milk, peptonized for a time, progress was rapid.

However, the results in these six cases, which lacked only the palpable mass to establish the diagnosis of congenital hypertrophy of the pylorus, inclined me to the belief that the genuine condition itself was amenable to dietetic treatment. So when I was called to see J. S., male, breast fed, 2 months old, weight 5 pounds, 15 ounces, with the characteristic history of vomiting after nearly every feeding (beginning when he was 2 weeks old), bowels moving only by enemas, and losing in weight; although examination showed a small, hard lump in the right side of the abdomen and immense waves of peristalsis after feeding, three weeks were spent in a vain endeavor to get a gain of more than 3 ounces. There was undoubtedly a slight opening in the pylorus, for the enemas came away with a yellow fecal stain, and this led me to persist in a conservative course, while there would be first a gain and then a loss of 3 ounces, with a little lessening of vomiting one day and an increase the next. A fluoroscopic examination by Dr. A. G. Miller of the German Hospital showed no bismuth passing the pylorus. Finally a survey of the three weeks showing no gain, I referred the patient to my colleague in the Children's Hospital of the M. J. Drexel Home, Dr. H. C. Deaver, who performed the operation of posterior gastroenterostomy. Recovery, as shown by Chart 2, was prompt and gratifying.

Therefore, I feel that if a mass is palpable, the diagnosis of hypertrophic stenosis is established and operation is indicated; but that in the absence of a mass, even if there is visible peristalsis, projectile vomiting, and failure of bismuth to pass the pylorus during Roentgen-ray examination, it is admissable to persist in dietetic treatment with further study. For even if we can only keep the weight stationary, the patient is growing older steadily with a possible increase in the chances for surviving operation should it be deemed advisable later.

CONGENITAL PYLORIC STENOSIS

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This condition was described by Beardsley in 1788. After it was brought to the attention of the medical profession, the number of cases reported each year has greatly increased. It is, at present, one of the most interesting surgical conditions because of the obscurity of the cause, the difficulty of recognition and the diversity of opinion as to the rationale of treatment.

It is met with in early infancy and is characterized by persistent vomiting, projectile in character, constipation, diminished urinary output, marked visible peristalsis, palpable tumor and daily loss of weight. Four-fifths of the cases occur in males. As a rule, the infant seems normal the first two or three weeks and shows no signs of gastric disorder. Suddenly it begins to vomit, at first occasionally, but soon habitually. The vomiting is not the ordinary regurgitation of an "over-full" stomach, but is projectile in character. It is most likely to take place immediately after the meal. Usually the food is unchanged. The vomitus contains no bile. Changes in the diet have no influence on the condition. The infant is hungry, the appetite often voracious, tongue clean, has no fever and no evidence of pain. The bowels are constipated and the urinary output is greatly diminished.

On examination of the abdomen, the epigastrium is usually full and the lower part of the abdomen is sunken. After the taking of food there is seen a slowly moving wave from the left to the right. A ball-like tumor about 2 inches in diameter appears just below the ribs on the left side and moves slowly to the right and upwards, at last disappearing just beyond the median line. The peristaltic waves are repeated every minute or two and can hardly be mistaken for anything else.

The course is progressive, the infant often losing 2 or 3 ounces daily. Unless treatment is successful, death occurs from exhaustion in about the fourth to the sixth week.

The etiology, by some, is attributed to spasm and by others to hypertrophy of the pylorus. The two terms pylorospasm and hyper-

trophic stenosis have been used interchangeably. We shall see that these formerly synonymous terms really represent different conditions. It has been on account of the grouping of all such cases under the same heading and their recognition as one definite clinical entity that such confusion has arisen.

Pylorospasm has its analogy in esophagospasm, spasm of the larynx and bronchi, spasmodic condition of the sphincters and the recently described condition, spasmophilia. Various theories have been advanced as to the cause of this tonic contracture of the pyloric sphincter. Gastric inability has been assigned by some. This is not the usual cause, however, because gastric analysis fails to show any marked deviation from the average. It is a definite fact that spasm may be caused by some extramural influence. Graham reports a case in which sarcoma of the orbit caused vagus stimulation and thereby induced vomiting. Hemmeter has found that pylorospasm may be a reflex condition during menstruation. Sir Lauder Brunton has observed spasm of the pylorus as a reflex condition in migraine. It is only recently that the motility of the stomach has been assumed to be of myogenic origin. In the light of the record work done by Gaskill, McCallum and others on the heart, it remains to be seen whether this could be due to excessive sodium and calcium ionization or a deficiency of potassium.

The second theory of hypertrophy is the prevailing one. Stillman advances the view that this must be a congenital anomaly, and this is probably correct. It is hard to see how such a tremendous increase of tissue could take place in so short a time as two or three weeks. Such increase of normal tissue is not in accordance with physiological laws of growth. Histological findings show nothing abnormal in the muscle and it has no resemblance to the rapidly forming embryological tissue of malignant growths.

Pathological examination reveals a hardened, cylindrical mass, about 1 inch in length. The increase is mainly in the circular fibers and in the connective tissue.

Prudden also describes an increase in the longitudinal fibers.

Thompson reports a case of increase in lymphoid tissue. The mucous membrane is uninvolved and hangs loosely in longitudinal folds. The canal, instead of admitting a size 16 French catheter, as in a normal case, will hardly admit the smallest probe.

In the stomachs where spasm is the causative factor, there is usually some hypertrophy. This, however, is limited to the pylorus proper

There is seldom much dilatation of the stomach. Graham reports a case in which, on postmortem, a normal stomach was found.

In real hypertrophic stenosis, the musculature of the pylorus is enormously increased and the nearby portion of the stomach may be involved. It is cartilage-like in consistency. The stomach may be dilated.

The chief difficulty that confronts the clinician is to be able to differentiate these two conditions. At present, only general rules can be laid down. If the vomiting is markedly projectile, if no element of irritation can be found and removed, if it is unresponsive to carefully outlined treatment, if it is continuous and nonremittent, if the tumor mass can be persistently palpated, if there is a loss of weight and a progressive loss of vitality, we are safe in assuming that it is a case of real hypertrophic stenosis.

The Roentgen ray with bismuth is a valuable help in our differential diagnosis in pyloric stenosis, and I think should always be resorted to, as we may determine just how patulous the pylorus may be. This would help us also in our treatment, because if the Roentgen ray show the pylorus completely occluded, we should operate immediately without giving medical treatment the slightest consideration.

The prognosis and treatment depend largely on which of the two conditions exists. Hutchinson, Bloch, Heubner and others probably owe their successful treatment to the fact that they treated spasmodic cases. Sarvonant, after a careful analysis of 115 cases, concludes that surgery is the better treatment.

The medical treatment, as such, consists in stomach lavage with water at a temperature of 108, colonic irrigations, and reduction of all food, especially fat. Hutchinson encourages a great reduction of food, thereby reducing the tonicity of the entire system. While in this condition of great exhaustion, he thinks the pylorus often dilates and allows food to pass.

The hypertrophic type is best treated surgically. In Stillman's series of ten cases operated, two died; of twelve treated medically, six recovered and six died.

The various operations performed are:

1. Pylorectomy
2. Gastroduodenostomy
3. Gastrojejunostomy
4. Pyloroplasty
5. Pylorodrosis

1. Pylorectomy is an unnecessarily severely procedure and is not to be recommended.

2. Gastroduodenostomy has been recommended by some, as especially suitable. In infants the duodenum is very movable and the stomach is more nearly vertical. These anatomic advantages, however, have not made the operation a clinical success. In Stillman's service, out of the two deaths, one was after a gastroduodenostomy.

The operation of choice is posterior gastro-enterostomy.

Sarvonant, in a series of 115 cases, prefers this. In Stillman's series of ten, eight recovered.

Pylorodrosis, Loreta's operation, is not to be recommended. The immediate results are good, but the morbidity is great. Out of twenty-one operations, eleven recovered, but many had to have a posterior gastro-enterostomy done later.

Dr. Stone of Boston is now trying out a series of cases. He has operated in three cases. The operation is to incise longitudinally down to the mucous membrane of the pylorus. So far, the results have been good, but the series is too small to draw conclusions from.

In conclusion, from my own personal experience, I should like to urge physicians to submit children for surgical treatment earlier. Too often our patients are moribund when first seen. This accounts largely for the appalling mortality of 50 per cent. Children stand ether well if properly administered, and the operative risk should not defer the needed surgical relief. Given such a case, the best treatment is combatment of acidosis with alkalies and immediate posterior gastro-enterostomy.

DISCUSSION

ON PAPERS OF DRS. HAND AND DEAVER

DR. HERRMAN: The first case that Dr. Hand mentioned was certainly unusual. I have never seen a case of this kind without peristalsis, and I should hesitate to make the diagnosis of this condition without its presence. Most observers now believe that the great majority of the cases of pyloric stenosis or hypertrophy are associated with spasm, and that the symptoms are due to the stenosis plus the spasm. Dr. Deaver says that the palpation of a mass is an indication for operation. I doubt whether all would agree with that; because many have seen patients with a palpable tumor that got well without operation.

In regard to pure pyloric spasm, excluding cases that vomit persistently for other reasons, and taking only cases with characteristic symptoms, I do not believe it is proved that there are cases of pure pyloric spasm without some hypertrophy of the pylorus—cases in which the characteristic symptoms are all present, and yet no change in the pylorus is found.

As to projectile vomiting, I think that this cannot be considered as a good ground on which to base a differential diagnosis or as an indication for operation. I do not think that most men now believe that there are two distinct sets

of cases: one of pure spasm and one of pyloric stenosis. The tendency is now to consider that the cases are mild, moderate and severe types of the same condition; and that the advisability of operation depends on the severity of the type of case and the progress of the child toward cure. I have had cases in which I advised operation and the parents refused to have it done, and yet the child got well; so it is very difficult to decide. It is the borderline cases that give us the most trouble at present. Many surgeons favor a simple operation (Rammstedt's), which can be done more quickly than can a posterior gastro-enterostomy. A longitudinal incision is made through the hypertrophied tissue down to the mucous membrane without going into the stomach. Without visceral suture or plastic operation the abdomen is closed.

DR. COIT: Recognizing the entity of congenital pyloric stenosis, I want to sound a note of warning with reference to the exercise of judgment in referring cases to the surgeon. This should not be done too hastily. I think that we should remember that congenital pyloric stenosis is an anomaly and is not of frequent occurrence.

I want to report a case in which the diagnosis of congenital pyloric stenosis was made by three consulting physicians. The radiographer was asked to make pictures of the case, which confirmed the diagnosis of the three consultants, besides the suspicion of the attending physician. A surgeon was employed and the child was to be put on the operating table the following morning.

Now I am not arrogating to myself a capacity for curing cases of congenital pyloric stenosis, for I do not think that this was a case of that kind at all, although the clinical evidence of its being so was marked and the roentgenologist thought that it was that condition. I saw the child on the evening of the day on which the pictures were taken. The patient had never retained a meal after the first week of life, either its mother's milk or artificial food. Nevertheless, the same child has never lost its normal food since the time I saw it.

At that time it was perhaps 5 or 6 weeks old. The mother's milk had been abandoned at the end of the fourth week. Projectile vomiting was marked, and I was told that there was peristalsis; but I did not get any evidence that there was a palpable tumor recognized. The condition was that of extreme atrophy. At birth the infant had weighed 8½ pounds, but when I saw it it weighed only 5½ pounds. The nutrition was low, the vitality was low, the skin was loose and putty-like, staying wherever one pushed it, as we see it do in cases of extreme atrophy. About all that the child could do was to functionate with its cardiac and respiratory systems, and it did have a little capacity to suck.

The baby had been for two weeks without its mother's milk, on various mixtures, and then was on whey.

I thought that there had been too much ultrascientific knowledge applied to the case, and that it was time to make an application of practical knowledge. I asked the mother to wash the nipples and give the baby some of the milk. It nursed for three minutes on the right breast and three minutes on the left breast. I had the bottle boiled, and it finished the meal with the whey in the bottle. It did not vomit a drop, but went to sleep, and a report was later given me that it had retained every meal of a complemental feeding with the breast milk.

Its temperature when I saw it was 94; but within one week its temperature was normal, its vitality had been raised and its capacity for living considerably elevated. It is now between 8 and 9 weeks old. We adopted the complemental bottle, but the form of nursing was continued. During the four weeks in which

the directions that I gave have been followed, the child has greatly improved. The attending physician was positive that the baby was suffering from pyloric stenosis, but it is now getting 3 ounces of breast milk, an ounce and a half from each breast, at each feeding. The milk obtained in this way contains less fat than the child would get if allowed to remain and empty the breast.

The roentgenograms showed stenosis of the pylorus. If it had been operated on, I think that the baby would have died on the table. The only lack in the clinical evidence of the existence of congenital pyloric stenosis at the time was in the history that there was no tumor palpable. It seems to me an interesting case, and one that should make the physician guarded in his judgment as to whether the patient should go to the surgeon or not.

I should like to announce that the picture was taken ten minutes after the ingestion of a bismuth meal. It shows no shadow beyond the pyloric ring. The second picture was taken twenty minutes after the meal and shows a little seeping through the pylorus. Then we could get the outline of the pylorus, but no shadow, in the picture taken an hour and a half after ingestion.

DR. MILLER: It seems to me that the question of operation in these cases rests on the severity and gravity of the symptoms. There is much discussion as to the nature of these cases, whether they are due to spasm or tumor, but it seems that to base the decision to operate on the presence of tumor would leave many unoperated cases where such interference is necessary. In fact, cases have been operated on and have shown a marked tumor, when no tumor was palpable before operation, and vice versa. The proper and safer indication for operation, I think, is simply the severity of the symptoms.

There is a point often referred to as indicating true stenosis and therefore possible operation, namely, the presence of retention. I have had a case, undoubtedly spasmodic, under observation for some time. This child's stomach is never empty. Although it is getting well, with no vomiting for months, there is still retention, from 1½ to 3 ounces four hours after feeding. Retention sometimes continues for eight or ten months, even into convalescence in these cases, so that is not much importance as a diagnostic point. It is the degree of severity of the symptoms that gives the indication for operation.

DR. DEAVER: I never operate in these cases unless I am able to detect a palpable mass. When I have had pylorospasm under consideration, and have been asked about the advisability of operation, I see whether I can feel a tumor; and in every case in which I have operated I have been able to palpate a thickened pylorus, which was as hard as gristle. In the two patients that died I could not get a probe through the opening. I do not lay so much stress on peristalsis as I do on the presence of a palpable mass; and I never operate unless I can feel one.

DR. HAND: I agree with Dr. Deaver that as soon as the diagnosis is made, early operation should be advised, and, I would add, by a skilled surgeon.

ACUTE INFECTIVE ENDOCARDITIS

DUE TO STREPTOCOCCUS ATTENUANS IN A CHILD ONE YEAR OLD

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Acute endocarditis, simple or malignant, is (with rare exceptions) a secondary and not a primary process. The morbid condition is the result of an infection by some micro-organism or its toxin. The action, Anders believes, is assisted by the friction between the blood current and the surfaces of the valves. The pathologic processes, though identical in nature, differ in degree and severity in the so-called simple, the intermediate grades and the more rapidly fatal or ulcerative type.

A good working classification, either etiological, anatomical, or clinical, is not easy to make. According to the *nature of the infecting* agent we speak of streptococcic, staphylococcic, pneumococcic, rheumatic, typhoid or gonococcic; according to *the character of the lesion,* of verrucose or ulcerative; according *to the severity of the symptoms,* of benign and malignant varieties.[1]

Lamb and Paton[2] report a case of vegetative endocarditis caused by a heretofore undescribed spirillum (*Spirillum surati*).

Dean recorded an example of generalized actinomycotic infection in which the endocardium was implicated. The elaborate and thorough work of E. Libman in particular, has given us valuable information regarding the cases of subacute infective endocarditis.

The most frequent cause is acute articular rheumatism, comprising about 10 per cent. of the acute cases. In lobar pneumonia Osler found it in eleven out of twenty-three cases. Septic conditions may also act as a cause. It has occurred in measles, tonsillitis, scarlet fever, typhoid, erysipelas, chorea, tuberculosis, etc.

The protean aspects of the disease are influenced or rather due to the specific character of the infecting organism. The manifestations may be those of septicopyemia, in which chills, fever, hemorrhages, septic emboli, etc., are due to suppurative lesions. Or in the non-sup-

1. Osler: Modern Medicine, 1908, iv, 133.
2. Lamb, Albert R., and Paton, F. Wade: The Archives Int. Med., Sept., 1913, p. 259.

purative forms, the picture is that of a septicemia with high and irregular temperatures. The symptoms are so diverse that in many cases it is impossible to differentiate the suppurative from the non-suppurative varieties. Not infrequently, when cerebral symptoms predominate, a lumbar puncture is advisable in order to exclude a possible meningitis. The cardiac symptoms vary. We may have extensive involvement of the valves with negative physical signs on auscultation. In other cases, more or less distinct murmurs, depending on the valves involved, may be discovered. As E. Libman remarks, "the absolute diagnosis rests on the cultural study of the blood."

In arriving at a diagnosis it is of the utmost importance to study the previous history and conditions under which the individual case occurs. With the symptoms referred to above and the evidences of emboli, petechiae, etc., a diagnosis is possible, even though cardiac murmurs are absent. Blood cultures, however, are necessary in order to establish the identity of the organism, the specific cause of the disease under consideration.

Streptococcic endocarditis is of frequent occurrence in adults. To judge from the literature it is extremely rare in patients as young as the following.

REPORT OF CASE

Rachel S., 1 year old, born in New York, was admitted to the children's ward (service of Dr. A. F. Hess) Dec. 20, 1914.

Family History.—Father and mother living and well. Two brothers and one sister alive and in good health. No history of any hereditary disease could be elicited.

Previous History.—The child was born at full term, delivery normal. Breast fed at the beginning, now receives milk three-fourths and water one-fourth; also other food from the table. No vomiting, convulsions or nervous symptoms reported. Appetite good, bowels regular.

The present illness began about four days before admission (although the child had been coughing for the past four weeks) with convulsions, dyspnea and cyanosis lasting about fifteen minutes. These symptoms subsided after an enema had been given. The child had another convulsion similar to the first, several hours subsequently, again two days ago and on the morning of day when sent to the hospital. The patient was constipated; a laxative was given, resulting in foul smelling greenish stools. There was no vomiting. Occasional cough was noticed; there was some dyspnea. Fever was marked. Since the onset of the trouble the child had been drowsy and very irritable.

On admission temperature was 101, pulse 146, respiration 40. General condition: Patient fairly well developed and nourished, slight dyspnea and cyanosis noted, no prostration or edema observed.

Eyes: Pupils equal, regular and react to light and accommodation. Petechiae present in conjunctival mucous membranes.

Nose, ears and mastoids presented no abnormalities.

Tongue clear and moist; pharynx and tonsils congested. No rigidity of neck; nasal, throat and vaginal smears negative.

In the lungs, with the exception of harsh respiratory murmur in right infraclavicular space and right axilla, the signs were negative.

The heart was not enlarged; a soft blowing murmur transmitted to the left and heard in the axilla was evident on examination. The second pulmonic was not accentuated.

The pulse was rapid, without any irregularity or intermission.

The abdomen was somewhat tympanitic, no tenderness or rigidity present. Liver was not palpable. Spleen was enlarged and could be readily felt about one finger below costal margin. The skin was hot and dry; glands not palpable, no rash present on the integument. Knee jerks active, no Babinski present.

BLOOD EXAMINATIONS

Date	12/21/14	12/23/14	12/27/14	1/2/15
Number	4,2000,000	.....	.....	3,100,000
Hemoglobin	75%	.....	.....	65%
White Blood Cells	27,000	24,000	20,000	26,000
Small Mononuclear	48%	.....	.....	.....
Large Mononuclear	6%	27%	36%	30%
Transitional	1%	1%	.....	.....
Polynuclear	45%	72%	64%	70%

Urine: Dec. 22, 1914: Straw color, acid, faint trace albumin, no sugar, acetone or diacetic acid — no bile, blood or pus. Same result when examined three days later.

Roentgenoscopy of joints and chest negative.

Dec. 28, 1914: Ears examined by Dr. Wolff Freudenthal; both drums normal.

Dec. 29, 1914: Blood culture revealed *Streptococcus attenuans.*

Bacteriologic Report by Dr. J. J. Hertz, Bacteriologist to Beth Israel Hospital.—Five c.c. of blood was obtained from the vein at the elbow, and divided in equal parts into two flasks, one containing 100 c.c. of 2 per cent. glucose bouillon and the other 100 plain bouillon. At the end of twenty-four hours the plain bouillon showed no growth. The glucose bouillon showed a streptococcic growth in chains of two to seven cocci. The organism was plated on blood agar plates and the colonies showed hemolysis. At the end of five days, the plain bouillon showed no growth.

January 1 with the change in the service, the patient was transferred to me. I take this opportunity to extend thanks for the courtesy of the case to Dr. Hess, attending physician.

Child well developed and nourished, was pallid, extremely irritable and restless, so that a thorough examination of lungs was not feasible. A distinct systolic murmur propagated to the left, was heard over the precordial region. Heart slightly enlarged, impulse fair. Spleen distinctly to be felt. Liver apparently normal; no jaundice present. Eyes somewhat sunken with dark circles underneath, face dirty waxy color. Tenderness over lower part of sternum, on which E. Libman lays stress, could not be elicited because of apathetic condition of patient.

This morning the child developed large patches of hemorrhagic spots about 2 cm. in diameter, over both cheeks and upper part of left chest. In addition small spots over right side of forehead. The rapid appearance of the patches

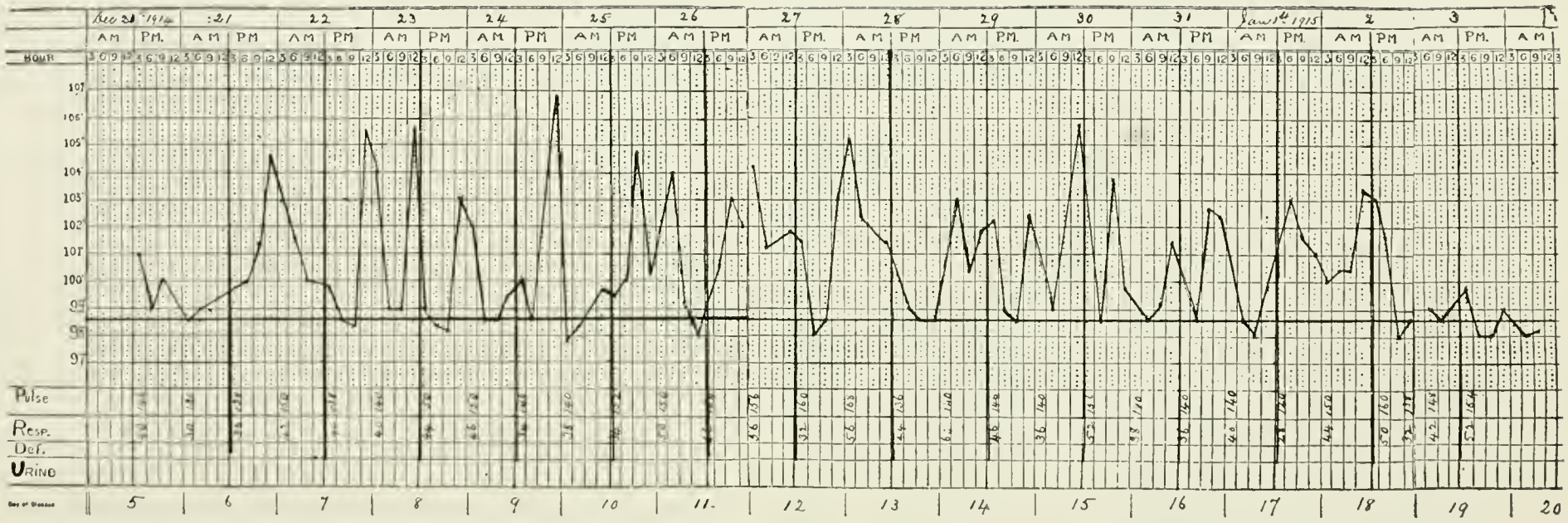

Fig. 1.—Temperature chart.

on the cheeks led the parents to imagine that the child had been slapped and abused. It was with the greatest difficulty that the father was convinced of the falsity of any such assumption.

Jan. 2, 1915: Punctate hemorrhages under left eyelid noticed this forenoon. Weakness progressive. Color more dusky; apathy more pronounced.

Jan. 3, 1915: Bloody stools and vomitus to-day; child failing.

Jan. 4, 1915: Progressively growing weaker; respiration more rapid; pulse rapid and irregular; color more sallow, anemia more marked; died of cardiac failure about 6 a. m.

Necropsy Report by Dr. Eli Morchowitz, Pathologist.—Lungs: Do not collapse. Pleura covered by numerous petechiae. Both lungs feel solid, only portions of upper lung are crepitant. On section lungs are salmon pink in color, firm, consolidated and fleshy in appearance. Bronchial nodes are not enlarged. Slight edema of both lungs.

Heart: Slightly enlarged. Left ventricle moderately dilated and slightly hypertrophied. The auricular surfaces of mitral flaps are covered by numerous firm verrucous-like vegetations, the largest projections being close to edges of valves. These vegetations are more extensive on the posterior flap where they extend upward on the auricular wall almost to opening of pulmonary vein. The vegetations are in part covered by a thin layer of fresh fibrin. In the neighborhood of the vegetations are a number of ecchymoses on the endocardium. The other valves of the heart are normal. Muscle slightly flabby and pale red.

Liver: Greatly enlarged; surface smooth. On section it is intensely cloudy, markings being very much obscured.

Gall Bladder: Contains green bile. Otherwise normal.

Spleen: Slightly enlarged, capsule tense, surface smooth and firm. On section, the pulp was firm and purplish red, malpighian bodies distinct, trabeculae prominent. Pulp does not scrape. There are two small fresh white infarcts just beneath the capsule.

Kidneys: Normal in size. On section very cloudy, markings indistinct, bases of pyramids congested. Scattered over the surfaces of both kidneys are a few minute petechiae surrounded by a narrow pale zone which extends for a short distance into cortex. Capsule not adherent.

Adrenals: Normal.

Intestines: Normal.

Mesenteric Lymph Nodes: Not enlarged.

Anatomic Diagnosis: Acute verrucous endocarditis of mitral valves; slight edema of both lungs; pneumonia of heart disease (bilateral); hypertrophy and dilatation of left ventricle; cloudy swelling of heart muscle; cloudy swelling of liver; chronic congestion of spleen with fresh infarction; cloudy swelling and chronic congestion of kidneys with fresh infarctions.

Microscopic Findings: Lungs: Walls of alveoli are slightly thickened; the capillaries are dilated. The majority of the alveoli are either partially or completely filled by red blood cells, fibrin and large cells of endothelial type containing a small amount of pigment. The bronchi and pleurae are normal.

Heart: The striae of heart muscle cells are obscure, nuclei stain faintly. Otherwise normal. Heart valve mitral is covered by masses of necrosed fibrin in which are numerous clumps of bacteria. The entire valve has been converted into granulation tissue. There is an abundant round cell and polynuclear infiltration and formation of new blood vessels. The muscular wall of the heart

adjacent to the valve is infiltrated with young connective tissue and formation of young blood vessels. This tissue separates the muscular bundles from one another.

Liver: Liver cells stain faintly, appear very granular, nuclei are pale. The liver cells contain a large number of fat globules. The capillaries around central veins are slightly dilated and the liver trabeculae in these regions are correspondingly narrower, the cells showing more pronounced granular and fatty degeneration.

Stomach: Normal.

Spleen: The splenic veins, especially in the cortex, are greatly dilated. The pulp is considerably congested. The center portions of the malpighian bodies stain lightly and consist of a delicate stroma of fine fibrillary connective tissue lined by large spindle cells of endothelial type.

Kidney: The epithelial cells of the tubules are coarsely granular; the cell outlines are indistinct, nuclei are sharply outlined. Most of the tubules contain a greater or less amount of granular material. The glomeruli are engorged with blood and the capillaries between the tubules are dilated and the capsule of Bowman reveal no changes. The infarcts are represented by a wedge shaped necrotic area in which the outlines of the tubules are distinctly visible. The infarct is surrounded by a well defined narrow zone of young connective tissue proliferation. The lymph nodes of mesentery are slightly edematous.

Uterus: Normal.

The treatment is symptomatic and unsatisfactory. Antistreptococcic serum has proved efficacious in a few cases. Brodbent thinks the vaccine treatment affords some promise of success. Dr. R. Abrahams[3] reports the case of a girl 22 years of age, who recovered, after three injections of auto serum.

NOTE.—Since the above was reported, another case in a girl about 4 years of age came under observation in the Children's Service of Beth Israel Hospital. The patient was admitted for rheumatic endocarditis and on routine examination of the blood streptococcus alternans was found. The case will be reported in detail at a later date.

209 East Seventeenth Street.

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3. Abrahams, R.: New York Med. Jour., Dec. 19, 1914.

REPORT OF THE COMMITTEE OF THE AMERICAN PEDIATRIC SOCIETY ON VAGINITIS IN CHILDHOOD

This investigation on the subject of vaginitis in childhood was carried out by means of carefully prepared questionnaires, designed to consider the subject from different standpoints. Seven series of questions were sent, divided as follows: 1. Health officers, cities and states; 2. Physicians; 3. Pathologists and Bacteriologists; 4. Hospitals; 5. Children's Homes, Training Schools and Asylums; 6. Gynecologists and 7, Social Service Departments in Hospitals and Visiting Nurse Societies.

The total number of questionnaires sent out was 2,487. The total number of replies received was 690 although many of these were in the form of letters in which no attempt was made to answer the questions. The number of available answers will be indicated under the separate questions.

Questionnaire 1 was sent to the chief health officer in each of the 48 states and in 109 cities of a population over 50,000, according to the United States Government Census of 1910. Thirty-two replies were received from states and 54 from cities, a total of 86.

In compiling a résumé of these replies it seems advisable to consider, not only the individual answers, but also the general impression conveyed by the collective answers.

The important points which the questionnaire was intended to disclose were: 1. Whether or not there is an appreciation on the part of health officers of the nature of gonococcus vaginitis in childhood, and an interest in attempting to deal with it effectively. 2. Whether or not any investigation has been made as to the prevalence of the disease in children's institutions, hospitals and schools. 3. Whether or not any laws, ordinances or rulings, have been passed by state and municipal authorities looking toward the control of contagion, and finally what suggestions are offered toward this end.

In determining the results, the care with which the questionnaires were answered was taken into consideration; on this basis, the following tabulation of the answers can be made:

"Appreciation" and "personal interest," but "no control" and "no investigation" 7
"Appreciation" and "interest"; some "control," but no "investigation"..... 13
"Appreciation" and "interest"; some "control," and some "investigation".... 9
"Appreciation," but only slight "interest"; some "control," but no "investigation" 3
"Interest," but so few cases encountered as to blunt "appreciation"; no "control" (except in one instance) and no "investigation"..... 5
No "interest" or "appreciation"; no "control" or "investigation"..... 44
Have never given subject adequate consideration; no "control" (except in one instance) and no "investigation"..... 5

To sum up, we find that the health officers in 32 of the 86 states and cities apparently have more or less appreciation of the nature and characteristics of gonococcus vaginitis in childhood. Only 9 of the 86, have instituted any investigation as to the prevalence of the disease, while 28 of the 86 have made some official attempt to control its spread. Usually this action has taken the form of excluding from school those children who were known to be suffering from vaginitis. In only 6 cities of the 54 heard from is "gonorrhea" a reportable disease. It is highly probable that these laws were framed for the control of venereal disease as it occurs in adults, and as these cities have no definite statistics to offer as to the number of cases of vaginitis occurring in children, it is also probable that few or no returns have been made.

The policy of permitting institutions and hospitals to make their own rules governing admission and care of vaginitis cases seems to be in general favor.

In 16 out of 64 cities and states heard from, however, hospitals are not permitted to discharge uncured cases to their homes.

With regard to the policy of having the school nurses examine school children for the presence or absence of vaginitis, 53 per cent. of the health officers heard from were opposed to it as a routine procedure and 47 per cent. were in favor of it.

In only 3 of the 32 states and in none of the cities heard from has any literature on the subject of vaginitis been prepared for distribution.

Of general interest is the fact that 13 city and state officers have encountered so few cases of vaginitis in childhood as to make the problem of official control seem to them relatively unimportant.

Finally, we may consider the suggestions made as to the control of the disease from the viewpoint of the public health official. Sixty

answers were received to this question, but comparatively few of them furnish any suggestion of real value in the control of a disease which is so readily transmissible and so difficult to cure.

In 10 instances, the health officers frankly admitted their lack of preparation to answer such a question, their attitude, very properly, being that it should be thoroughly discussed and considered before the attempt is made to decide on a proper course of procedure.

The rather glib answers of a few others show a complete indifference to, or lack of knowledge of, the disease vaginitis, or an inadequate conception of the broad and comprehensive duties of a health officer. Still others believe that education of the public and profession must precede public health measures. A few are frankly pessimistic of results. The salient points of some of the remaining answers may be quoted, with some abbreviation:

"Ultimately by examination of all school children."

"Make vaginitis a reportable disease. Isolation or hospitalization till recovery. Isolation and prolonged quarantine are the only measures to combat the disease successfully."

"Education of parents and guardians, medical school inspection, restraint of hospital from discharging patients until at least 3 cultures are negative."

"Strict isolation. All institutions receiving state aid to provide special isolation wards. Make vaginitis a reportable disease."

"Reportable disease. Periodic examination of children in asylums, institutions and schools, with enforcement of proper treatment. Examination without treatment useless."

"Children's clinic. Isolation. Registration of cases and follow up treatment by trained nurse."

"Systematic and conscientious medical inspection, quarantine and treatment."

"Local and state laws controlling public institutions and admission to schools."

"Examination, isolation-quarantine, hospital treatment."

"Reportable disease under full control of health department."

"Isolation hospitals, examination by both physicians and nurses, under supervision and control of health department."

"Isolation until cured, in both institutions and hospitals. Exclusion from school following examination by trained school nurse. Report of all gonorrheal infections in adults."

"Compulsory report by physicians. Voluntary report by district nurses. Isolation. Education of adolescent masses. Public sentiment not yet prepared for earlier education."

"Isolation and quarantine until discharge is over and then periodic examinations for several months afterward. Exclusion from public schools."

"Wherever found should be treated as violently infectious disease and strictly isolated until negative bacteriological test is made. Gonorrhea (and syphilis) in adult ought to come in same category—although public health work as yet is not so far advanced."

"Reportable disease. Revoke licenses of physicians who fail to examine bacteriologically and properly treat all questionable cases. Certificate of recovery for all cured cases before dismissal from hospital or institution. Inspection of all school children and treatment when indicated. Bacteriological examination of all confinement cases and when findings are positive, careful examination of infants."

Questionnaire 2 was sent to members of "The American Pediatric Society," "The Association of American Teachers of Diseases of Children," "The Philadelphia Pediatric Society"; to subscribers to the 1914 issue of the Transactions of the Section on Diseases of Children of the American Medical Association, and to the Fellows of the Association who registered at the Section on Diseases of Children at the last three meetings, held at Los Angeles, Minneapolis and Atlantic City.

Avoiding duplications, so far as possible, the total number of physicians to whom the questionnaires were sent was 587. The replies received numbered 145, although in many of these, no attempt was made to answer the questions.

Approximately half of the physicians believe that vaginitis in childhood is caused by the gonococcus in 90 per cent. or more of cases while only 5 per cent. are inclined to doubt the agency of the gonococcus. The remainder place the percentage at less than 90. Several emphasize the difference in the disease vaginitis as it occurs in private, and in hospital patients. In the former, they believe that the percentage of cases due to the gonococcus may be very low, or nil, while the percentage of positive hospital cases varies from 75 to 100.

Four-fifths of the physicians believe that the gonococcus found in these cases of vaginitis is the same, or essentially the same, as the organism which is found in adults, and half of this number have seen one or more instances where a gonococcus vaginal discharge has been the direct infecting agent of gonococcus ophthalmia. [The latter disease is generally admitted by ophthalmologists to be a true Neisserian infection, regardless of age, in from 60 to 65 per cent. of cases.]

The percentage of positive results in the differentiation between simple and gonococcus vaginitis might be larger were greater care taken in making smears, as fifteen out of ninety-one physicians content themselves with securing material for the smear from the external genital region.

With regard to the incidence of the disease, 13 per cent. of physicians find an increase in the number of cases in private practice of

late years; 23 per cent. find an increase among ward patients and 28 per cent. find an increase among dispensary patients. Less than 2 per cent. find a decrease in the number, in each class.

Several questions were designed to determine whether or not gonococcus vaginitis is considered to be a serious disease and what complications or sequelae, direct or indirect, may be caused by it.

Seventy-six per cent. of the physicians believe it to be a serious disease, either to the child itself or because of the danger of transmission to others, and 39 per cent. have seen more or less severe systemic complications such as pus tubes, arthritis, pelvic or general peritonitis, septicemia, endocarditis, ophthalmia, etc., occurring in sixty or more cases. Of these at least four were known to have ended fatally.

Although 85 physicians have never known of an instance where a nurse was infected during a ward epidemic of vaginitis, 10 physicians have seen such an occurrence. In 6 instances the nurses' eyes were infected, and in one of these, the sight was lost.

With regard to the persistence of gonococcus vaginitis after puberty, opinion seems to be equally divided; only 11 out of 96 physicians, however, have had as adult patients those whom they had treated for vaginitis during childhood. Five of the 11 have seen no complications while 6 ascribe certain sequelae such as sterility, pelvic peritonitis, tendency to abort, etc., to the infection acquired before puberty.

The majority are unequivocally in favor of making true gonococcus vaginitis a disease reportable to the health officers, while a few favor certain restrictions, such as withholding the patient's name, etc.

In attempting to determine the chief sources of infection in private practice, it is difficult to interpret correctly some of the answers. For example, 11 physicians ascribe the cause to "direct transmission" and 7 to "traumatic pollution." The latter term, presumably, is intended to indicate legal rape; the former may or may not be so intended.

Grouping the various principal causes, as indicated in the answers, we find the following, the figures indicating the number of times each cause was mentioned:

Indirect contact with adults or adult members of the household; chiefly in bed, but probably not immoral	69
The toilet, or toilet articles (of which, in 12 instances, the school was specified)	53
Nurse or attendant	28
Direct transmission, probably immoral	8
Direct or indirect transmission from playmates, probably immoral	5
Clothing	5
Diapers and dressings	4

Further data with regard to private patients with gonococcus vaginitis show that they usually do not infect members of their own family before the disease is cured, while, as a rule, they show a larger proportion of cures than the hospital type of patient.

On the interesting question as to the cause of outbreaks of vaginitis in a supposably clean ward, we have the following expressions of opinion: 36 physicians ascribe it to latency of old infections or failure to examine smears or to both; 27 physicians ascribe it to the hands of nurses, attendants, or physicians; and 16, to bedding, utensils, toilets, failure to sterilize diapers, etc.

Thirty-four physicians advocate the discharge of the primary case as soon as possible or justifiable, while 59 prefer to treat the cases as they occur; 52 physicians find that secondary cases develop more or less frequently, in spite of all precautions, and 42 do not have this experience.

The medium whereby infection is carried to these secondary cases is, of course, practically impossible to demonstrate, with absolute scientific accuracy, but the greatest suspicion seems to be directed as follows, in the order of importance: Nurses' hands, diapers, bath tubs, syringes and wash cloths, bedpans, towels and bed clothes.

According to the experience of 22 physicians, it is necessary to clear the ward of all female patients in order to check epidemics, while 58 do not find this necessary. Thirteen out of 85 physicians have seen gonococcus infection develop in male children during a ward epidemic.

As might be expected, the variations in the answers to the question concerning treatment are almost as numerous as the answers themselves. For irrigation, solutions of permanganate of potash evidently are most in vogue, while strong solutions of the organic preparations of silver, or weak solutions of nitrate of silver, are equally popular for instillation and local applications. In these results the statistics given in the questionnaire sent to hospitals are included. The vote for vaccines stands 20 for and 11 against.

As to the time required for a cure, the estimates vary from 6 days to 6 years or more. Ruling out 18 answers, which are indefinite, 53 of 71 physicians consider that the time varies from 6 weeks to 6 months. One believes that cure comes only at puberty.

Equally, or even more indefinite, are the answers to the question as to the requirements which must be fulfilled before a cure is established.

Absence of discharge and repeated failure to find the organism in smears of the vaginal secretions for at least two months after all treatment has been discontinued seems to be the average requirement. In addition to negative smears, 12 physicians also demand one or more negative cultures, and 4 make use of the complement fixation test in addition to smears.

With regard to the possibility of cure, we find that 23 per cent. of physicians believe that cure is possible in all cases, with appropriate and persistent treatment, while 11.4 per cent. believe that cure, in a strict sense, is impossible or very doubtful. The remainder make various estimates or else do not know, since cases usually are not under their observation long enough to permit of forming an opinion. Over one third of all physicians ascribe more or less importance to the factor of "individual resistance."

Eighty-one per cent. of the physicians encountered subsequent attacks in supposedly cured patients, and 85 per cent. ascribe them to the recurrence of a latent infection rather than to reinfections. Only 5 per cent. definitely express their belief that reinfection plays the leading rôle. One physician, who has made a careful and systematic study of cases in a dispensary which is devoted exclusively to the treatment of vaginitis in children, believes that at least 80 per cent. of second attacks are true recurrences and not reinfections.

In order to condense into reasonable limits the various suggestions as to lessening the incidence of the disease, it will be necessary to group them under different headings and to score under each heading the number of points which belong to it according to the answers received.

This method has been followed in correlating the answers to other questions. While the final result may not correspond at all to the opinions of the individual with regard to relative values, it at least indicates what factors the majority held to be most important, since it is to be presumed that a physician, in answering, expresses what he holds to be the measure of greatest value even if he does not specify all of the factors which seem to him of less value. Many physicians enumerate all of these measures, and in each case the points are scored accordingly.

	Points
First.—Hospital Care	88
Under this heading are included, isolation, prolonged treatment till cured, improved technic in handling and in treatment, special instruction to nurses, adequate number of nurses, especially at night, etc., etc.	
Second.—Instruction to the Laity	52
Under this heading are included printed and verbal instructions as to the nature of the disease, danger of transmission, best means for prophylaxis, etc.	
Third.—Schools	20
Examination and exclusion of positive cases, care as to the toilets, etc.	
Fourth.—Control by boards of health	16
Compulsory report of cases, compulsory treatment, etc.	
Fifth.—Physicians	15
Instruction as to the importance of early recognition, prolonged treatment, etc.	
Sixth.—Institutions and tenements	11
Adequate medical supervision, care as to toilets, etc.	
Seventh.—Medical-sociologic relief	7
Systematic sociologic study, follow-up nursing, etc.	

It will be seen that the majority of physicians believe that the control of the spread of vaginitis in childhood involves chiefly the question of adequate isolation and thorough treatment of patients in hospitals, and secondly, instruction of the laity as to the nature of the disease and the best means for avoiding infection.

In summing up the opinions of physicians and health officers, we find that gonococcus vaginitis usually is a true Neisserian infection; that it should be reportable; that the infection outside of hospitals results from carelessness and ignorance, with immorality playing an insignificant rôle; that, with regard to contagiousness in hospital practice, the disease ranks with the exanthemata; that cure is obtained with great difficulty, and that, owing to the liability of the disease to become latent, and thus to simulate cure, the potentialities for spreading the infection are greatly increased, and that thorough hospital treatment of the patient with instruction, and, if need be, legal control, of the laity offer the best hope for limiting the spread of the infection.

The questionnaire to gynecologists was sent to all members of the American Gynecological Society, and to a number of other gynecologists of whom your Committee had knowledge. One hundred and thirty-seven (137) questionnaires were thus distributed to all parts of the country.

Forty-five (45) replies have been received, but sixteen (16) of these do not meet the purpose of this report, as the senders either had had no experience or their experiences had been too limited to warrant an expression of opinion.

The fact that only one-third of the gynecologists appealed to replied at all, and further that a third of these had little or no experience, would seem to indicate that this group of practitioners are not often consulted about the disease; or that they are not sufficiently interested in research, or in public health matters to induce them to answer twenty questions.

A number of questions were identical with those sent to pediatrists. The replies to these will be omitted in this résumé except where they materially differ from those just summarized, or where the opinions of the gynecologists should be more authoritative.

The gynecologists do not consider the gonococcus the cause of as large a percentage of cases of vaginitis in children as do the pediatrists, but two-thirds of them believe that it is the etiologic factor in 75 per cent. of such cases, while only one-fifth think it is responsible for less than 25 per cent.

Effort was made to determine the anatomic sites affected and the relative frequency of involvement of certain parts. Twenty-six opinions have been received. Six of these (about one-fourth of the entire number) are to the effect that no structures other than the vagina are involved, while four include only the vulva and urethra in addition to the vagina. Only fourteen (about one-half) of the observers mention any portion of the urinary system as being a possible focus. No more than eleven (42 per cent.) think that the cervix or uterus ever shows evidence of the disease. Eleven (42 per cent.) believe that the infection may extend beyond the internal os; (one of these thinks that such involvement occurs in about 10 per cent. of all cases of gonococcus vaginitis, while the others claim that this infection very *rarely* extends beyond the internal os). Five say that the fallopian tubes may be affected, but only one of these definitely states that he has ever seen such involvement, although another has seen two cases of gonococcus peritonitis which he assumes may have been from tubal extension.

One-half of the gynecologists have never seen involvement of the vulvovaginal glands, while only four (15 per cent.) claim that the glands are frequently affected (three stating that they are seats of

disease in 10 to 20 per cent. of cases). Rectal infection seems to be fairly frequent, as one-fourth of twenty-nine observers have noted it, one-half of the cases being secondary.

As to general infection, systemic complications and sequelae, not more than five of twenty-six gynecologists have seen arthritis, dysmenorrhea, gynatresia, peritonitis or sterility following gonorrheal vaginitis. One observer has operated on young women for gynatresia which he regards as having been caused largely by gonorrheal vaginitis in childhood; he has also operated on a number of cases for sterility and dysmenorrhea due to adhesions caused by pelvic peritonitis in childhood.

Only three of the gynecologists have treated adults who were known to have had gonococcus vaginitis during childhood. One has seen no sequelae, the other two have had to operate, one for pelvic peritonitis, and the other for peritonitis, salpingitis and oöphorritis. Although so few have seen instances in which vaginitis during childhood has manifested itself by sequelae in later life, 30 per cent. of the twenty gynecologists who expressed an opinion, positively state that gonococcus vaginitis of childhood may last after puberty; 40 per cent. more or less qualify their affirmative reply; the remaining 30 per cent. either definitely deny or gravely doubt its persistence.

That the gonococcus can remain latent for long periods in the vagina or cervical canal, is the belief of one half of the gynecologists, most of whom accept this theory as explanation of the majority of second attacks. About a third, however, think that the most of these apparent relapses are due to reinfection. Latent infection (unrecognized carriers), is also credited, in one-third of the replies as the cause of the so-called primary attacks in children who have been in hospital wards for weeks or months before showing evidence of the disease. The general opinion, however, is that most of these cases are due to contact with some infected individual, such as visitor, nurse or attendant, or to contact with some object that harbors the micro-organisms.

There seems to be great lack of uniformity in the methods of securing preparations for microscopic examination. Six claim to use a urethroscope or speculum to facilitate the collection of material from the points most diseased; four attempt to secure the discharge in a glass pipet, two of these using the pipet to flush the vagina

with a small amount of weak bichlorid solution, and then centrifugating the solution and making a spread from the sediment. The majority, however, secure their specimens by means of a platinum loop, sterile applicator, or sterile cotton swab. While three are apparently content to examine smears from the vulva and urethra, the majority advise that the preparations should come either from the discharge or from as near as possible to the affected part.

No two gynecologists recommend the same treatment, but the majority (58 per cent.) advise frequent douching, with 1:6000 permanganate solution, by the mother or nurse, and less frequent instillation of protalgol or argyrol, or the direct application of silver nitrate or the organic salts of silver to the affected area by the physician. Two advocate the use of the cystoscope in making applications. Three recommend autogenous vaccines; one says that vaccines are of no value. The necessity of general and local cleanliness is urged by only about one-third of the gynecologists, while only one calls attention to the desirability of thoroughly drying the affected parts before making direct applications.

Practically all the gynecologists believe that gonococcus vaginitis is readily amenable to treatment, provided the cases are well controlled, but one-fifth consider that the results under the conditions that usually pertain are most unfavorable, chiefly because the treatment is not sufficiently thorough or prolonged. A number recommend treatment in a hospital ward as the only safe procedure.

The replies to the query as to "What would be a safe rule on which to consider a case cured" are so much like those secured from the pediatrists that they will be omitted here. Suffice it to say that the gynecologists demand a longer period of negative returns. Two are content with the absence of all physical signs, disregarding laboratory tests; one of these requiring such freedom for six months, and the other for one year. Two demand two negative complement fixation tests before they are willing to pronounce a case successfully concluded.

Only two gynecologists believe that the disease is becoming more prevalent. Not more than 64 per cent. of this group of practitioners are inclined to consider the malady a serious one so far as the infected child is concerned.

Two hundred and thirty-six (236) questionnaires were sent to a selected list of the members of the Association of American Pathologists and Bacteriologists; to the members of the American Bacterio-

logical Society, and to the bacteriologists of the various state boards of health. Forty-nine (49) replies were received, but only thirty-seven (37) of these could be utilized.

Seven questions were propounded for the purpose of ascertaining the value of bacteriologic tests as aids in the diagnosis of gonococcus vulvovaginitis. The laboratory workers were asked to state what evidence is required before an organism can be positively identified as the gonococcus.

Approximately one-third replied that such identification is possible by observation of the morphologic and staining characteristics of the organism and by observation of its relation to other structures in the smear preparations, i. e., by the fact that the gonococcus is an intracellular Gram-negative biscuit-shaped diplococcus. However, one-half are of the opinion that the diagnosis may be safely made when such organisms predominate; when they are found in a profuse discharge from a situation susceptible of infection with the gonococcus; and when pus cells are present in proper position to the bacteria, especially when they show an increase of acidophilic granules. Three-fourths of the bacteriologists believe that the percentage of error in this method of examination is very small, although most of them do not depend on the test. About one-third require typical cultural reactions in addition to these morphologic characteristics in order to fix the identity of the organism; one-half of these advocates of the cultural method of differentiation demand it regardless of the clinical history and physical signs of the case, or of the evidence gained from cover-slip preparations of the discharge.

The cultural characteristics most commonly insisted on are: That the organism should not grow on ordinary media, but readily develop on ascitic, hydrocele or blood-agar at body temperature, with the formation in ascitic-agar of moist, tiny, transparent, drop-like colonies of Gram-negative diplococci of short longevity. These colonies should have thin, irregular, elevated edges and a crumb-like appearance on the center of growth. The culture must ferment dextrose, but no other forms of sugar. The pure culture does not affect ordinary test animals.

Only about one-third of the bacteriologists seem to think that a positive complement fixation test should be secured before a suspicious organism may be accurately classified as a gonococcus. A third

more, however, have some faith in the value of the complement fixation test, although they do not seem to need it to identify the gonococcus.

In answer to the question as to whether a complement fixation test should be considered positive evidence of gonococcal infection, thirty (30) replies were received, of which number 23 per cent. are unqualifiedly affirmative and 23 per cent. more state that it is conclusive evidence under certain conditions, viz., when it is performed by a skilled serologist with satisfactory antigen and adequate controls; when the infection involves the deeper structures, and when it has been of long enough duration to cause the production of specific amboceptors. Thus 46 per cent. of the bacteriologists who replied state that evidence gained by a complement fixation test is *conclusive* under certain conditions; 30 per cent. more believe that it is of *value* under these conditions, especially when the test is positive. Hence 76 per cent. of laboratory workers have more or less confidence in the serologic method of diagnosing gonococcus vaginitis. Twenty-three per cent. either positively deny its value or gravely doubt it. They claim that the chances of error are too great—as the Gram-negative group can give group reactions (common antibodies are formed); or that the infection in children is frequently too superficial to give a complement fixation test; and that it is unquestionably valueless except possibly in the hands of a bacteriologist who has had wide experience with this special test. About one-half of those who question the value of this test, however, do so on theoretic grounds, frankly stating that they have had little or no experience with gonococcus infection in children.

Forty-five per cent. of the bacteriologists attach no significance to the presence of extracellular Gram-negative diplococci with few or no leukocytes in smears of vaginal secretion, while 19 per cent. more simply value it as suspicious evidence in cases of very recent or very chronic infection. Thirty-six per cent. consider it of enough weight to warrant further tests.

The organisms that most resemble the gonococcus are the meningococcus, the *Micrococcus catarrhalis*, certain Gram-negative cocci and diplococci; Gram-negative streptococci in broken chains and Gram-negative short bacilli, but they may all be differentiated by well-known

methods. The bacteriologists apparently believe that when the gonococcus is isolated, it can be positively identified. This adds weight to the replies to the specific question as to whether the Gram-negative intracellular diplococcus usually found in cases of vaginal discharge of children is the true gonococcus. About 18 per cent. are of the opinion that the usual organism is not the true gonococcus.

In regard to the value of the vaccine treatment of gonococcus vaginitis, the opinion of the bacteriologists differ greatly. Approximately two-thirds believe in it to the extent, at least, of favoring its trial (in conjunction with the local measures) in selected cases, such as the chronic and the subacute. Only five of twenty-seven bacteriologists unqualifiedly state that they believe in this treatment. While nine do not have confidence in it. Two call attention to the fact that superficial infections are relatively less influenced than are deeper ones by changes in immune substances in the blood.

The majority favor the use of autogenous vaccines, but many of these admit that it is frequently impossible or impracticable to secure autogenous vaccines, in which case they sanction the use of a stock preparation, preferably a polyvalent stock vaccine. About four-fifths of the bacteriologists say that properly made and administered, vaccines are free from danger. The other fifth deny that they are harmless.

Questionnaire 4 was sent to all the children's hospitals in the United States and to a selected list of the largest general hospitals which maintain a children's service—539 in all. One hundred and forty-one answers were received although many of them failed to return the questionnaires.

The duplication of answers, similar to those in the questionnaire to physicians, was almost entirely avoided by the obvious disinclination of any physician to answer two such formidable lists of questions, one in his individual capacity and one in his capacity as visiting physician. Most of the questionnaires to hospitals were filled out through the office of the superintendent.

The first questions were designed to show the relation of the number of cases of vaginitis to the total number of girls treated at the various hospitals.

According to the figures returned there were 31,924 patients admitted to children's hospitals or children's wards and 78,828 patients

treated in dispensaries in 1913. Assuming that half of these were girls, we have 55,376 potential victims of vaginitis. Seven hundred and ninety-nine of these were reported to have vaginitis, and 412 of these were due to the gonococcus, a percentage of the total cases of 0.74 per cent.

When we realize how often cases with vaginitis are refused admission to hospitals, and the frequency with which a vaginitis complicating some other disease fails to be recorded in the annual report, from which the figures probably are taken, this surprisingly small percentage of cases can be more easily explained.

The records of hospitals show that vaginitis was recorded as a separate diagnosis only within comparatively recent years, the year 1891 being the earliest, according to the answers in the questionnaires. This means either that the disease did not occur to any great extent before that time or failed to be properly recorded as a complication. In view of the well-known characteristics of the disease as it exists at the present day, it seems hardly probable that it could have been ignored. Within the last few years, since vaginitis has been recorded, one-sixth of the hospitals find an increase in the number of cases.

Since the diagnosis of latent carriers is such an important factor in preventing the introduction of the infection into the wards, it is surprising to find that 54 per cent. of the hospitals do not make routine microscopic examinations of the vaginal secretions of girl applicants unless there is a visible discharge or reason to suspect infection!

The technic employed for detecting the presence of gonococcus vaginitis is too varied to permit of indicating it in this résumé. On the basis of known facts that no smear gives an adequate picture which has not been taken from the depths of the vagina and that no staining method can be relied on which does not include the Gram differential stain, we find that the technic, as described in the questionnaires, is inadequate in 19 hospitals and adequate in 40.

In the presence of visible discharge, 43 out of 53 hospitals accept the morphologic microscopic test as presumptive proof of true gonococcus vaginitis, but in 17 out of 55 hospitals the microscopic diagnosis is made by the intern, or, in one instance, by the head nurse. In the remainder, the pathologist or chief of service passes judgment.

The policy of not admitting cases to the general wards until after the examination of the smear is followed by 26 hospitals, while 34,

or 57 per cent., admit without waiting for the results of examination, except in the presence of vaginal discharge.

The great majority of hospitals require only one smear test on admission, and a somewhat smaller proportion do not repeat the test during the child's stay in the hospital, except in suspected cases.

Through an error, the question as to the policy of admitting or refusing cases of vaginitis was included in the questionnaire to physicians instead of that to hospitals.

Approximately one-seventh of the physicians report that cases of vaginitis are admitted to the general wards of hospitals with which they are connected; four-sevenths report that such cases are not admitted at all while two-sevenths state that special wards or rooms are used for such cases.

As to the disposition of cases which are refused admission, only 6 out of 37 hospitals apparently fail to make any attempt to secure treatment for them, either in the dispensary, the home or in some other institution. Forty per cent. of the hospitals do not maintain observation wards for newly admitted cases. In those that do, the period of observation before the cases are admitted to the general wards, varies from 1 day to 3 weeks. In 12 hospitals, the time varies from 1 to 7 days; in 5 hospitals, from 8 to 10 days, and in 5 hospitals from 14 to 21 days. Twelve others detain cases an indeterminate time, "until the diagnosis is made."

A bare majority of hospitals (averaging 30 to 28), use individual soap and thermometer lubricant as a routine measure. A decided majority (58 to 8) use individual or single service wash cloths and towels. Thirty hospitals use single service diapers and 41 do not. Thirty-one use individual thermometers and 34 do not.

A slight majority (averaging 35 to 27) do not use individual powder, ointment or syringes, and a large majority (averaging 41 to 18) do not use individual wash basins, bathtubs and bed pans.

It must be understood that the figures above refer to the routine procedure, and not to the method employed in caring for communicable diseases.

The enumeration of the methods used for routine sterilization of utensils, clothes, etc., may prove to be somewhat lengthy, yet the results are of sufficient interest to justify its presentation.

In 13 out of 45 hospitals, a solution of bichlorid of mercury or of carbolic acid weaker than 5 per cent., is used to disinfect thermometers. Alcohol, formalin or 5 per cent. carbolic solutions are used in the remainder.

In 13 out of 31 hospitals no attempt is made to sterilize the thermometer lubricant.

With regard to the sterilization of utensils and clothes, a surprisingly large number of hospitals rely on the use of chemical solutions instead of on an adequate degree of heat. Although nothing short of the autoclave can be relied on as an absolute germicide, a temperature of 212 will answer all practical purposes. Less than this, however, surely is hardly to be recommended, unless we are to fall far below the standards set by our surgical confrères.

The use of autoclave or boiling water in the sterilization of utensils, etc., is used in the following proportion of hospitals:

Bath tubs	in 5 out of 29 hospitals
Wash basins	in 20 out of 38 hospitals
Bed-pans	in 14 out of 37 hospitals
Syringes	in 27 out of 31 hospitals
Wash cloths	in 23 out of 32 hospitals
Towels	in 20 out of 30 hospitals
Bed clothes	in 38 out of 62 hospitals
Diapers	in 27 out of 41 hospitals

Disinfection of the nurse's hands, or at least a thorough washing, after caring for each patient, is required as a routine procedure in 50 out of 63 hospitals. In three instances, the note is made that the nurses require constant watching in order to enforce the rule.

The technic of disinfecting the nurse's hands consists chiefly in the use of soap and water followed by some antiseptic solution. In 7 instances the antiseptic used is alcohol. In the remainder, various strengths of bichlorid, carbolic, lysol or formalin are used after washing, except in 9 hospitals where reliance seems to be placed in simple immersion and rinsing of the hands in the so-called antiseptic solutions. Fifty hospitals supply single service towels or gauze, and 11 state that the general service towel is used routinely.

In only 38 of 64 hospitals are the nurses required to make a daily routine examination of every girl patient for the presence of vaginitis, and in 2 others, examination is made two or three times a week.

Fifty-six per cent. of 62 hospitals report that they have had no primary cases of gonococcus vaginitis which developed in the ward

in spite of routine precautionary measures within the past one to six years.

When such cases develop, 10 hospitals discharge them as soon as possible, 2 discharge them unless they are seriously ill, and 46 treat them, 10 specifying that they are transferred to the isolation ward. Half of the 46 treat them until cured of the original disease or as long as circumstances will permit, and half treat them until "cured of the vaginitis," or, at least, until the smears are negative.

With regard to the routine measures adopted to prevent the spread of vaginitis in a ward, the greatest importance seems to be attached to improving the nurses' technic, and especially, to limiting the duty of certain nurses to the vaginitis cases only. Next in importance is the isolation of suspected cases, and next is the use of individual utensils and single service diapers.

With regard to the special precautions required of nurses who are caring for cases of vaginitis, the greatest reliance seems to be placed on the use of rubber gloves, next on the proper care of the hands and next on wearing the cap and gown—one hospital also specifying the need for wearing goggles.

The great majority of hospitals (86 per cent.) claim to be able to prevent the spread of vaginitis from a primary case to other patients in the ward.

Nine hospitals find less tendency for the disease to spread since single service diapers have been used and six have not noticed any difference.

Concerning the requirements for defining a cure, the viewpoint of the hospital, naturally, is somewhat different from that of the individual physician, the great majority of hospitals being satisfied with two or three negative smears after treatment has been discontinued for one or two weeks.

The variety and especially the severity of complications reported by hospitals somewhat exceed those reported by individual physicians For example, in 10 out of 33 hospitals, cases of gonococcus ophthalmia or ulcer of cornea were recorded.

Cases of vaginitis are not treated in the dispensaries of 18 hospitals. Of 28 which treat cases, 10 conduct a special dispensary or clinic and 1 delegates a physican in the gynecological dispensary for the treatments. In 1 hospital, the effort to maintain a special clinic

for vaginitis was discontinued because no physician could be prevailed upon to conduct it!

The importance of giving prophylactic instruction to parents is recognized by 37 hospitals, and takes the form of printed rules or lectures, teaching in the home by social workers, etc.

With regard to the attitude which children's hospitals should adopt in regard to the subject of vaginitis, the suggestions offered lay greatest stress upon securing proper facilities for effective isolation and treatment of cases in every hospital which treats children. The next point is the routine careful examination of smears before admission to the general wards. The third important factor is the maintenance of observation wards for at least 4 to 7 days, and, what is considered equally important, providing an adequate number of nurses to care for cases effectively, and especially, the avoidance of overwork for the night nurse, who, if rushed with work, frequently is responsible for carrying infection from patient to patient.

Other points, less emphasized, are the importance of treating cases until cured of the vaginitis as well as the original disease; special care as to sterilization of utensils, etc.; taking smears of all females routinely and repeatedly after admission; the maintenance of a special clinic for treatment; follow up case in the home, etc.

Questionnaire 5 was sent to 710 children's homes, training schools and asylums throughout the United States, according to the lists published in the Directory of the American Medical Association. One hundred and sixty-seven replies were received, many of them merely letters of regret that the questions could not be answered.

According to the figures returned, 3.1 per cent. of the female inmates of various institutions suffered from vaginitis during 1913, and approximately one-third of this number were cases of gonococcus infection. These percentages probably are not accurate, but with those from hospitals they serve to emphasize the ubiquitous nature of the disease in every type of institution which harbors children. About seven-eighths of 80 institutions claim that they refuse admission to cases of vaginitis. Two-thirds do not make smears for microscopic examination on admission to the institution unless a discharge be present. One-sixth repeat this examination at various times during the child's stay, but only one-fourteenth make a final examination before the child is discharged.

Forty-one per cent. of 94 institutions report that they maintain an observation ward in which the children are sent for an average stay of twelve days.

The single service diaper is used in only 2 of 51 institutions but almost three-fourths of the remainder claim to use the autoclave or boiling water for sterilizing diapers, while 45 per cent. boil the bed clothes, etc., before sending them to the laundry.

Ninteen per cent. of 94 institutions admit that they have had cases of vaginitis which apparently developed in the institution, but none would admit that they were unable to prevent its spread to other children. It must be confessed that this rather throws a damper on the too enthusiastic acceptance of some of the other figures from institutions.

The disposition made of the cases which develop is of interest: 41 institutions treat them, usually under more or less rigid quarantine precautions; 14 send them to hospitals which are equipped for treatment, and 10 discharge them, usually to the care of some physician.

The favorite treatment again seems to consist of the use of solutions of permanganate of potash and silver nitrate. Complications recorded are few.

The basis for pronouncing a case cured, according to 42 reports, is as follows:

When the discharge has ceased	3
When the discharge has ceased for over a month	3
When the smears are negative	34
When cultures are negative	2

The suggestions as to the attitude which children's institutions should adopt with regard to vaginitis may be summarized as follows, according to the point system used throughout this report:

	Points
Isolation, including the use of the observation ward	20
Careful examination before admission and careful technic in treatment, *each*	14
Exclusion of cases, referring them to a hospital or physician for treatment	13
Repeated examination during child's stay in the institution	6
Education of parents	3

Questionnaire 7 was sent to 121 hospital social service departments and visiting nurse societies; 50 answers were received from the former and 9 from the latter.

Sixty-eight per cent. of those from whom answers were received report that they are prepared to care for cases of vaginitis, but only 25 out of 59, or 42 per cent., supervise or administer treatment in the home. It should be noted that all of the visiting nurse societies supervise or carry out home treatment while only 16 of the social service departments perform this service.

It is difficult to see how a disease like vaginitis can be successfully treated without some supervision in the home. If this be true of the educated classes—which most of us will admit—how much more true is it of the hospital type.

In the answers to the next question which shows the sources from which cases of vaginitis were referred for care and treatment, we also have an index to the number of cases reported by 35 agencies.

256 cases referred from hospitals or in-patient departments.
176 cases referred from out-patient departments.
56 cases referred from receiving wards.
34 cases referred by physicians.
30 cases referred by mothers.
26 cases referred by social workers.
17 cases referred from day nurseries.
15 cases referred by charity organizations, life insurance companies, etc.
A total of 610 cases.

It is a matter of some interest to know what precaution the nurses take in order to avoid carrying the disease from one patient to another. Judging from the answers received, 22 have an adequate appreciation of the dangers to be avoided, and 6 show evidence of treating the subject with much more indifference than it deserves.

The viewpoint of the intelligent and well informed social worker or nurse offers a distinct advantage in attempting to trace the source of the infection. According to their observation infection can be traced as follows:

	Cases
To other members of the family	102
To hospital wards	107
To hospital dispensaries	1
To playmates	31
To sleeping arrangements	14
To toilet and bathing facilities	10
To public schools	8
To private schools	0
To temporary institutions	13
To permanent institutions	1
To day nurseries	5
To bad habits or character	15
To rape	8
Doubtful	93

Eight of 25 reports show an increase in the number of cases of vaginitis within recent years. Of 38 social service departments reporting on cases which are refused admission to their in-patient departments, 25 state that they are referred to other hospitals or physicians, 12 state that cases are treated in their own dispensary, and in 1 instance, referred to visiting nurse society.

The attitude of social workers and visiting nurses toward the question of attendance at school is shown by the following:

Parents advised not to allow patients to attend school	34
Cases reported to the health authorities for control	3
Advice dependent on instructions from physician	7

It was hoped that the data with regard to the end-results obtained, as reported by social service departments and visiting nurse societies would be of interest. As a matter of fact they are useless for statistical purposes and so difficult of interpretation that it is impossible even to draw inferences. Only three of the answers were definite. These state that one-fifth, three-eights and five-sevenths, respectively, of cases treated during the last year were cured!

The difficulty is manifest of securing the mothers' cooperation, and in carrying out the necessarily prolonged course of treatment, after the subsidence of active symptoms.

Certain of the other answers show a due appreciation of the difficulty of determining an absolute cure. On the whole, the impression gained from the answers is that the disease can be checked by suitable treatment, but that the proportion of uncured cases, and therefore of carriers, is undeniably large.

In closing, the committee hopes that this résumé has not offended too much the very desirable quality of brevity. While the reports from various sources could have been combined, such a procedure would have sacrificed the various viewpoints of those who were kind enough to take the not inconsiderable trouble of answering, and to whom we wish to express our deep appreciation.

The general conclusion of the committee with regard to the subject of vaginitis, both as a result of this study and from our individual experience, may be summed up as follows: It seems to be only too evident that a disease which may prove fatal; which, not rarely, causes more or less serious complications; which is so easily transmitted; which requires such an expenditure of time and money and such

extensive equipment for its successful isolation and treatment; which so frequently is allowed to interfere with the proper treatment of even more serious and fatal diseases; which may be followed by sequelae in adult life, and which without extreme care may cause blindness—is not a disease to be regarded lightly or slightingly, but one which requires careful handling but which also merits serious consideration in the attempt to limit its spread and to devise more efficient methods of treatment.

The committee was continued in order to investigate particular phases of the disease. The final report of the committee will come up for action by the society in 1916.

CHARLES A. FIFE
J. CLAXTON GITTINGS
HOWARD CHILDS CARPENTER,
Chairman.

PRELIMINARY REPORT OF THE SPECIAL COMMITTEE ON CHILD LABOR

At the last meeting of the American Pediatric Society, Dr. Hamill, in his presidential address, called the attention of the Society to the need of an authoritative statement from medical men in support of, or in opposition to, existing and proposed laws dealing with child labor, such a statement to be based on scientific facts. The committee appointed to report on this subject has interpreted its reference as follows:

"Child Labor, with Especial Reference to the Effects of Various Forms of Labor, and Labor in General, Upon the Physical and Mental Development of the Growing Child, and to What Extent Its Legal Regulation, Existing or Proposed, is Warranted by Established Medical Facts."

The committee has not considered that the economic aspects or the moral effects of child labor are within the scope of its reference.

At the very outset, the committee was struck with the scarcity of reliable statistical data upon the extent of child labor and the almost complete absence of *evidence* of a medical nature dealing directly with its defects. Medical *opinion* there is in abundance.

At the present time the committee is only able to report progress, with a brief statement of the lines along which the work is being done, for your criticism and suggestion. Investigation is being carried on as follows:

I. A study of the available data dealing with the extent of child labor in the United States.

The thirteenth census states that 16.6 per cent. of all boys and 8 per cent. of all girls from 10 to 13 years of age in the United States are engaged in gainful occupations. An analysis, however, shows that of the, in round numbers, 609,000 (609,030) boys and 287,000 (286,946) girls, 89.8 per cent. and 87.3 per cent., respectively, were engaged in agricultural pursuits, 74.9 per cent. and 75.4 per cent. as "laborers on the home farm."

On the other hand, in the fruit and vegetable canning industries, the census gives only twenty-nine boys and twenty girls from 10 to 13 years of age as employed. It is well known that thousands of children

work in the canning sheds for many weeks each year; also thousands of children are engaged in "home work" in the tenements, neither of which groups are included in the official figures. Even the tabulation of the extent of child labor, therefore, entails considerable search for information.

II. A detailed study of the various industries and occupations in which children are engaged; the character of the processes in these industries and occupations in which they are, or might be, advantageously employed; and the conditions under which they work.

The manufacture of cotton textiles ranks first among child employing industries in the United States. "It employs more children than any four others combined. More than one-quarter of all children (under 16) gainfully employed are engaged in their manufacture." The census figures for 1910 show 11,911 boys and girls from 10 to 13 years old so employed, or 3.3 per cent. of all the workers in the industry.

A very thorough and careful study has been made of this industry. Without going into detail, it may be stated that, while conditions vary in many ways in various factories and localities, there are certain conditions inherent to the manufacture of cotton textiles which are bound to exist and which warrant careful study as to their possible harmful effects. Among such may be mentioned long hours, excessive physical and mental strain, dust-laden atmosphere, excessive artificial heat and humidity.

A special investigation was carried on by the Department of Labor in 1908, which covered approximately 25 to 30 per cent. of this industry in the United States. It was absolutely proved that among 81,335 employees, children were reported in the following numbers:

7 years	17
8 years	48
9 years	107
10 years	283
11 years	494
12 years	1,394
13 years	1,957

A total of 4,300 children under 13 years of age, or nearly 5.3 per cent. of all employed. The following extract from the above mentioned report may be of interest:

"Ordinarily this overtime work was paid for at the time it was performed and there was no record to show its extent. In the case of one family, however, the names of workers were entered on both the day roll and the night

roll and this record showed that 4 children, 2 boys, (doffers,) one 10 and one 15 years old, and 2 girls, (spinners.) one 11 and one 13, and also a youth of 17 years old, all members of the same family, had been paid for 78 to 84 hours of work per week. They had worked this number of hours, less a little time for supper and breakfast, on days when extra work was done. It was found that during a considerable part of the eight months that this family had been at this mill these children had worked two or three half nights each week, in addition to day work. After working from 6 a. m. to 6 p. m., with 35 minutes for dinner, they had returned to the mill, usually every other night, immediately after supper and worked until midnight, when they went home for four or five hours of sleep before beginning the next day's work; or, they had been aroused at midnight and sent to the mill for the second half of the night, where they remained until 6 o'clock the following afternoon, except when eating breakfast and dinner. In either case, they were on duty for a working day of 17 hours, with no rest period save for meals. Those who worked the second half of the night went home for a hurried breakfast just before 6 a.m. The mill stopped only 35 minutes out of the 24 hours, from 12 m. to 12.35 p.m. On one or two occasions two younger children of the same family, one a girl (spinner and spooler-helper) 7 years old, and the other a male (doffer) reported 10 years old but apparently 8, had worked half of the night in addition to day work." In another mill "One girl of 10 years, a spinner, was employed at night who during the preceding year had ordinarily worked 8½ hours on Saturday, after working 12 hours Friday night, making a continuous day of 20½ hours with intermissions for meals only. She had also worked 6 hours on Monday about one-third of the time, and a few times she had worked all day Monday and all night Monday night—a continuous period of 24 hours with about 35 minutes for dinner and the same for supper. The mill did not stop during this time, except for 35 minutes at midday. Three sisters of this child, all spinners, one 12, one 14, and one 18 years of age, were night workers and worked overtime on Saturdays and Mondays to about the same extent."

Similar studies have been made of glass manufacture and the canning industry. Several others are well under way.

III. A study of the effects of conditions existing to various degrees in different forms of labor, with especial reference to the developing and mature organism.

The interaction between the several special senses and the systems performing the various and independent bodily functions is much more intimate in childhood than in adult life. This applies equally to the motor and sensory portions of the central nervous system; to such functions as sight and hearing; and also to the osseous and muscular systems. The facts and conditions which have already been found to exist are being studied with special reference to their effects on the various systems of the body, as follows:

A. Respiratory Tract:

1. The influence of abnormal atmospheric conditions, such as high temperature, high artificial humidity, and sudden and rapid changes in temperature on the mucosa of the nasopharynx and larynx, the development of the tonsils,

and the production of adenoid growth. The relation of constant exposure to moist, warm air or steam to the early development of atrophic conditions of the upper respiratory tract.

2. The special susceptibility of the bronchial mucous membrane in youth to irritation from dust and gases.

3. The tendency of bronchial affections in youth to become pulmonary.

4. The effect of cramped positions and lack of variety and freedom of motion on the proper development of pulmonary space and range of respiratory movements.

B. Circulatory System:

1. The effect of the maintenance of one position for long periods of time on the muscular aid to return circulation.

2. The influence of repetition of the same movements on the blood supply to certain parts at the expense of others and its bearing on even and symmetrical development.

3. The influence of poor hygienic conditions and anemia on the nutrition of the rapidly growing heart wall and their secondary results.

C. Skeletal and Muscular Systems:

1. The effect of a lack of diversity of position and movement:
   i. In the production of flat feet, spinal and postural deformities in general and maldevelopment of chest and abdominal muscles, etc.
   ii. In its bearing on fatigue, an expression of poor elimination of the products of muscle waste and the particular importance of fatigue in the growing body.

2. The abnormal destruction of proteins in exposure to great heat. A child's ability to accommodate to changes in temperature and humidity is relatively poor. When perspiration is interfered with the unstable temperature centre of the child responds abnormally. The capacity for work is reduced and yet the pace set by the machine must be kept up with.

D. Central Nervous System:

1. The effect upon the nerve centres in children of repetition of same motions; the ability to develop reflex, unconscious coordination.

2. The influence of monotony, restraint and deprivation of usual amusements, in its tendency to depress all originality of thought and mental relaxation.

3. The susceptibility of the central nervous system to poor nutrition and toxemias due to defective elimination.

E. Sight:

1. The prevalent moderate errors of refraction in youth as a cause of:
   i. Constant internal strain in near work.
   ii. General bodily strain and fatigue.
   iii. Congestion and disease of the conjunctiva.

F. Hearing:

1. The effects of continued exposure to loud noises: the relation thereof to fibrosis and contraction of drum, thickening of lining of middle ear, with spasm of Tensor Tympani muscle.

2. The influence of vibrations received on body surfaces as shown in:
   i. Effect on the internal ear structure.
   ii. Development and health of labyrinth and cochlea.

3. The local and general effects of maldevelopment of these organs.

G. Pubescence:

1. The particular relation of various conditions to general growth and development at this time.
2. The particular influence on the pelvic organs in girls.
3. The reflex influence on the nervous system in general.
4. The tendency to anemia at this time of life.

IV. A study of occupational mortality statistics and the susceptibility of the child to certain diseases.

V. A study of available anthropometric data to determine if possible the influence of race, heredity, etc., in establishing normals for various ages.

VI. A study of the restrictions on the labor of children at present existing and the further restrictions advocated by those interested in child labor legislation with application to them of the principles recognized as medical facts.

It may be stated that direct evidence as to the effect of labor on children as shown by careful studies on working children covering a period of years, are practically nonexistent. This fact renders the efforts of the committee all the more difficult. Your committee also is unable to state at the present time its conviction that convincing undisputed evidence will be obtained, but it is willing to continue its labors if the Society so desires.

PHILIP VAN INGEN, Chairman.
HENRY L. K. SHAW.
HERBERT B. WILCOX.

REPORT OF THE COMMITTEE TO COOPERATE WITH THE FEDERAL CHILDREN'S BUREAU

The Committee on Cooperation with the Children's Bureau reported that Miss Julia C. Lathrop, the Chief of the Bureau, had expressed gratification at the appointment of the committee.

A number of minor matters have been referred to the committee for its criticism, and several conferences have been held with Dr. Grace L. Meigs, who has charge of the medical work of the Bureau.

SAMUEL MCC. HAMILL.

GENERAL INDEX

American Medical Association Press
Five Hundred and Thirty-Five North Dearborn Street
CHICAGO

American Pediatric Society
Transactions